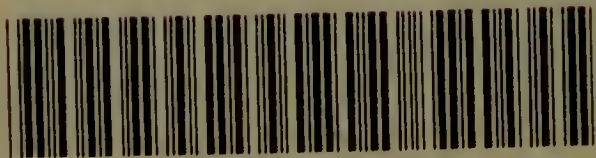


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CAR. I. TABORIS.



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DESCRIPTIVE AND ILLUSTRATED CATALOGUE

OF

THE PHYSIOLOGICAL SERIES

OF

COMPARATIVE ANATOMY

CONTAINED IN

THE MUSEUM

OF

THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.

VOL. I.

SECOND EDITION.



LONDON:

PRINTED FOR THE COLLEGE;

AND SOLD BY

TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET.

MDCCCC.



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PREFACE

TO THE

FIRST EDITION.

THE Council of the Royal College of Surgeons now present to the public the fifth and last volume of the descriptive and illustrated Catalogue of the Physiological series of Comparative Anatomy contained in the Museum: thus completing an important design, which Mr. Hunter was prevented from accomplishing by his sudden death.

The primary objects of the Catalogue have been, to give a clear and succinct description of each preparation, to determine the species of animal or plant to which it belongs, to place it rightly in the proper series, and thus to afford to the visitor of the Museum every facility for studying and understanding this important department of the collection.

Before the formation of the present catalogue, the printed works, from which information could be derived respecting the physiological collection, consisted of the published writings of Mr. Hunter, the subjoined Synopsis of the Hunterian collection, and the Lectures on Comparative Anatomy by Sir Everard Home. The latter profess to explain the Hunterian collection; but they contain descriptions of a small number only of the preparations, and these descriptions are unaccompanied by any reference to the particular specimens.

The 'Synopsis' is here reprinted *, because it exhibits the arrangement of the physiological series which preceded that adopted in the present catalogue ; and, while it indicates the nature and extent of the changes which have been introduced, enables the scientific reader to understand more readily the reasons that are given for them. The alterations consist, for the most part, of a return to the arrangement originally employed by Mr. Hunter, and have been either suggested by the Hunterian manuscript catalogues, or made with the view of obtaining greater simplicity and consistency, and a more regular subordination in the several groups of preparations. The Hunterian documents, for example, seemed clearly to show that it was not the intention of the founder to place the preparations of 'Elastic substance as a substitute for muscle †' in a subseries distinct and remote from that which illustrated 'Elasticity in aid of muscular action ‡.' No adequate advantage was gained by retaining the subseries of 'Gizzards §' distinct from that of 'Stomachs with a superadded crop ||.' The physiological relation of these cavities to each other, and the modifications of a single and definite plan of gastric structure, were obviously better illustrated by retaining in the same series all the gradations of complexity in the stomachs of birds, which form the most natural and best defined class in the animal kingdom.

As the progress of science is chiefly characterized by the reduction of supposed anomalies to recognized general principles, the physiologist, who may compare the present with the preceding arrangement of the physiological collection, will not be surprised at the suppression of many of the groups of preparations which formerly swelled the series entitled 'Peculiarities in vegetables and animals ¶.'

Osseous substance, for example, is a material of the framework, not of animals in general, but of one only of the primary groups of the class ; the substances, therefore, 'of which the

* [Omitted.]

† Subseries 5.

‡ Subseries 23.

† Subseries 17 of the Synopsis.

§ Subseries 28.

¶ Series XII.

skeleton is composed in animals not having bone *,' as the shells and their opercula † in Mollusks ; the calcareous crusts and horn-like coverings of the Articulate animals ; the corals and madreporic secretions of Zoophytes, for the defence and support of their delicate gelatinous organs, cannot be regarded as 'Peculiarities,' but as essential members of the normal system of organs of support, equivalent to the bones of the vertebrate animals. The subseries numbered 116, 139, and 140 in the synopsis, have, therefore, been removed from the series of peculiarities, and made to precede the parts of the skeletons of the Vertebrata in the first subdivision of the present arrangement.

Changes in the second division of the physiological collection have been made in conformity with the same principles that have regulated the alterations from the arrangement of the synopsis, already noticed ; and chiefly consist in the reduction of the formerly extensive series of 'Fœtal peculiarities.' For as every condition that characterizes the progress of the germ to its extrication from the fœtal coverings, or which disappears during that progress, or is suppressed after birth, may be termed a 'fœtal peculiarity,' numerous preparations had been transferred from the older series illustrative of the phænomena of fœtal development in different classes of animals, and had been brought together in the twentieth series of the arrangement of 1818, in contravention of the special purpose of such older series. Certain stages, for example, in the formation of the vitelline sac, exhibiting as many modifications of its relation to the embryo, were shown in one series of preparations ‡ ; other stages were exhibited in another series § ; and a later condition, under the title of 'Yolk received into the stomach ||,' formed a third separate group. All such specimens have been brought together in the present arrangement and placed in a consecutively ascending order, subdivided only according to the class of animals, the evolution of which such preparations successively illustrate.

* Subseries 116.

† Subseries 140.

‡ Series XVIII., Subseries 193.

§ Series XX., Subseries 208.

|| Series XX., Subseries 211.

Thus modified, the series corresponding with that entitled in the synopsis, 'Incubation of the ovum in birds,' now exhibits all the successive stages described by Mr. Hunter in his admirable account of the 'Progress and peculiarities of the chick*.'

It seemed a sufficient reason for suppressing the twenty-first series of the 'Synopsis,' that the preparations included therein exhibited stages of development nearly connected with those which preceding series were expressly established to demonstrate. The preparations illustrative of generation by artificial fission † have thus been re-united to those exhibiting the same effects by spontaneous fission ‡. The preparations exhibiting the 'changes of the tadpole into the frog §' are now combined with the analogous and connected specimens constituting the group entitled 'Ova of animals which have gills when hatched, but afterwards lungs ||.' By thus combining the later with the earlier stages of development in the oviparous classes, the consecutive phænomena of such development in one series are brought under the immediate observation of the physiological student, and he is made familiar with the earlier stages of the formation of the vitellicle and allantois before he arrives at that series (the nineteenth in the synopsis) in which further changes of the allantois are exhibited, and its subserviency to the formation of the placenta is demonstrated.

The preceding observations explain the plan of arrangement adopted in the present catalogue of the Hunterian physiological collection. The following remarks refer to the descriptive part of the same catalogue, and particularize the sources of the additional information that may be found in the present, when compared with the previously existing catalogues.

The printed synopsis, already quoted, is limited to an explanation of the subjects of the several series and subseries of specimens. The catalogues descriptive of the individual specimens have hitherto existed only in manuscript.

* Introd. to the Fifth Volume, p. viii.

† Series XXI., Subseries 219.

‡ Series XVII., Subseries 176.

§ Series XXI., Subseries 222.

|| Series XVIII., Subseries 194.

The original documents explanatory of the physiological department of the collection are the following :—

First, A manuscript catalogue, in Mr. Hunter's handwriting, without date, but probably written soon after his return from Portugal in the year 1763. It briefly defines the nature of about two hundred specimens. In this catalogue the natural and morbid structures are grouped together in classes according to the organs; there is then a short series of 'Monsters,' followed by specimens of natural history, under the heads of 'Beasts,' 'Lizards,' and 'Snakes.' The articles included in the two latter series were collected for the most part in Portugal, Spain, and Belleisle. This was the germ of the future Hunterian collection, and the foundation of its several departments, the pathological having been afterwards separated from the physiological preparations. It may not be uninteresting to record the first method of classification, in which the specimens are arranged according to the organs. It is as follows :—

Class I.—'Of the Brain, Medulla, and Nerves;' then follow, 'Heart and Vessels;' 'Larynx and Œsophagus;' 'Stomach,' 'Intestines,' 'Anus,' 'Liver,' 'Gall-bladder,' 'Spleen,' 'Kidneys,' 'Capsula renalis,' 'Parts of Generation,' 'Eyelids,' 'Eyes,' 'Ears,' 'Nose,' 'Tongues,' 'Skin,' 'Bones,' 'Epiploon,' 'Oils,' 'Ligaments.'

The series of the 'Kidney' includes, even at this early period, specimens of the injected tubuli uriniferi in the Monkey ('S. 6,' now No. 1235); in the Horse ('S. 9 and S. 10,' now Nos. 1209 and 1210); and in the Ass ('S. 12,' now No. 1208). The same series likewise displays the superficial arborescent veins in the kidney of the Lion and Leopard, and the reticulate arrangement of the same veins of the Seal, and it terminates with the conglomerate kidney of the Porpoise. The series of the 'Nose' contains the preparation of the fifth pair of nerves in the nose, figured in the "Animal Œconomy, Pl. XVII. and XVIII.," where it is described as having been made in the year 1754*. The original number of this specimen in the old catalogue is 'c. 4,' it is now No. 1550: it has thus been preserved eighty-

* Animal Œconomy, 1792, p. 261.

seven years, and may be considered one of the oldest, if not the oldest Hunterian preparation in the collection. The latest date which can be attached to any preparation in the present manuscript catalogue is 1764 ; the preparation is the duodenum of a woman who died of a dysentery, and whose case is described in "Dissection 78, of Morbid Bodies, winter of 1764."

The *second* descriptive document, called the small catalogue, is a small octavo manuscript without date, in the handwriting of Mr. William Bell, and of others who assisted Mr. Hunter. The number of the physiological preparations noticed or described in this catalogue is 561.

The most valuable of the original Hunterian documents relating to the present department of the Collection is the *third*, or quarto catalogue. It consists of twenty thin fasciculi, in 4to, in the handwriting of Mr. William Bell and others, with additions and corrections written by Mr. Hunter himself.

The following are the Titles of the 'Fasciculi,' and their order of succession. Some of the titles are in Mr. Hunter's handwriting :—

- "No. 1. Simple animal matter and moving parts.
- "No. 2. Growth of bone, horn *, &c.
- "No. 3. Composition of the skeleton, application of muscles, &c.
- "No. 4. Stomachs.
- "No. 5. Intestines.
- "No. 6. Absorbents.
- "No. 7. Hearts, blood-vessels, &c.
- "No. 8. Respiratory organs.
- "No. 9. Kidneys.
- "No. 10. Brain and nerves.
- "No. 11. The senses.
- "No. 12. Cellular membrane, fat.
- "No. 13. Coverings of birds.
- "No. 14. Cuticle, hair, horn, hoofs, &c.
- "No. 15. Horn, cuticle, &c.
- "No. 16. Growth of teeth, feathers, hair, horn, &c.

* Antler, or the bony horn of deer, is here meant.

“No. 17. Growth and structure of teeth.

“No. 18. Teeth (dry preparations).

“No. 19. Peculiarities and regeneration.

“No. 20. Reproduction of animals.”

Most of the fasciculi commence with general observations on the series of organs to which they respectively relate ; and these valuable expositions have been introduced, with a few verbal corrections merely, in their appropriate places in the present catalogue. The arrangement of the Physiological collection, as it is thus shown to have existed at the decease of its Founder, has been strictly adhered to, except in one particular, viz. the position of the series of the teeth. In the time of Mr. Hunter, when the teeth were usually enumerated by anatomists among the bones of the skeleton, probably no other physiologist would have thought of classifying them with hairs and horns. Some of their striking relations to the extravascular productions, thus early appreciated by him, have been subsequently insisted upon by other philosophical anatomists *, to the exclusion of the facts and arguments which are still valid for regarding them as appendages to the osseous system. The series of the teeth was, however, removed from its old position by Sir Everard Home to that which it occupies in the printed ‘Synopsis’ of 1818, viz. between the ‘Stomachs’ and ‘Intestines,’ or the 4th and 5th of the Hunterian series : it was subsequently transferred by the Senior Conservator, Mr. Clift, to its present position at the commencement of the digestive system.

The chief value and importance of the original Hunterian quarto catalogue consist in the information which it supplies respecting the scheme of arrangement and the general physiological principles intended to be illustrated by the different series. The descriptions of the individual preparations are comparatively few, and these, for the most part, are confined to a brief definition of the object. Many had merely the name of the animal or part written on the top of the bottle, and the rest were without either name or number. It was from these materials that Dr. Baillie, Sir Everard (then Mr.) Home, and Mr.

* See Heusinger, ‘System der Histologie,’ 4to, 1823, Heft ii. p. 160.

Clift commenced, in the year 1793, the formation of the folio catalogue, which constitutes the *fourth* of the manuscript explanatory documents of the present department of the Hunterian Collection, and which served for the use of visitors until the publication of the present catalogue. In reference to the notation of the specimens in the folio catalogue, Mr. Clift has subjoined the following note, prefixed to the list of the different numbers :—“No *running number* existed during Mr. Hunter’s “lifetime, on account of the additions continually making to the “Collection. Immediately after his death, a running number, “from 1 to 3745, was painted upon them by the Conservator, in “order to construct a catalogue from materials left by Mr. “Hunter. This was done between the years 1793 and 1800 by “William Clift, under the superintendence of Mr. Home, and “afterwards written fair into the folio volume above mentioned, “after the Collection had come into the hands of the College. “A slight inspection of that volume will show that the preparations were not in a sufficient state of arrangement for a “permanent catalogue; the whole contents of the Gallery were “therefore re-arranged, and brought into their present relative “situations in the year 1817, and the whole re-numbered, as in “the first column of this book, under the direction of Sir Everard “Home. But a further more careful revision is still necessary “before a satisfactory catalogue can be made.—1823. WILLIAM “CLIFT.”

Before placing on the specimens the new series of numbers of 1817, Mr. Clift copied off all the memoranda which had been written in paint on the tops of the bottles; to these he has added notes, elucidating the history of many of the preparations; and the three manuscript Fasciculi, containing the original memoranda attached to the specimens, and these additions, constitute the *fifth* explanatory document, and one that has proved of material use in the determination of many of the unnamed specimens. Of the descriptions to which the new system of numbers was designed to refer, those relating to the first series alone were completed, so that the rest of the Collection could only be studied by the folio catalogue of 1793—1800, through

the medium of the lists of double numbers, written fair in a separate volume by Mr. Clift.

A *sixth* document, of much importance in the identification of the individual specimens, is a manuscript catalogue, by Mr. Hunter, of a series of drawings, chiefly taken from preparations in the Museum, and intended to illustrate their description. About thirty specimens, in some instances of complicated and minute structures, have been determined by this mode of comparison.

The original Hunterian descriptions have been retained, as far as possible, in the present catalogue; additions have been made to them, when they were found not sufficiently clear; and new descriptions have been given of all the remaining preparations.

The information most commonly required in addition to the previous descriptions and notices, has been the name of the species of plant or animal from which the preparation had been derived.

Where this information is attempted to be given in the manuscript catalogues the reference is commonly to the genus or to some still wider group of animals, as 'a monkey,' 'a whale,' 'a beetle,' 'a snail;' or the indication is still more vague, as 'an insect,' 'a sea-worm,' 'a shell-fish,' &c. In a great proportion of the specimens the description relates only to the organ, or ends with 'animal unknown.' In many cases, where the species is more definitely indicated in the folio catalogue, rectification of the name has been found necessary, as will be seen by whoever may compare the present catalogue with that document. The mistakes which have hitherto been detected, have arisen from placing confidence in the statements as to the species of animal contained in the manuscript documents, before experience of their occasional fallacy had shown the necessity of testing them by a dissection of the animal to which a preparation was so referred, or by a comparison of the preparation with such descriptions and figures of the anatomy of the same animal as could be found in print.

It is impossible to reason correctly upon the structure of a

detached organ, unless the condition of the rest of the organization, and the habits and mode of life of the species, be known; but to this end the name of the species from which the detached organ was derived is indispensable: without this fact, the contemplation of the most elaborately dissected specimen can yield little satisfactory information, and to determine it became therefore the first and most essential step in the formation of a catalogue of the physiological specimens. This part of their history has in most cases been effected by a comparison of the Hunterian preparations with recent dissections. The series of 'Natural History,' or entire animals preserved in the Museum, the numerous specimens presented by different travellers, and the permission liberally granted by the council of the Zoological Society, of taking to the College of Surgeons for comparison the viscera of the animals dying in their extensive menagerie, have afforded such means of instituting the requisite examinations, that the expectation expressed in the Preface to the First Volume of the present work, "that few of the preparations will ultimately be found deficient in that part of their history which is most essential to their utility," has been fully realized.

In some instances the unknown specimens have been determined by sufficiently characteristic descriptions and figures in the published works on comparative anatomy. In many cases sufficient of the animal has been preserved to determine the species from external zoological characters, and of these the smaller Invertebrate animals are the chief examples. In most instances this information has been gained by comparison with recent dissections.

The species of organized beings dissected by Mr. Hunter are systematically arranged in the 'Zoological Index' to the five volumes comprising the present catalogue. This index will show at a glance the range of Mr. Hunter's researches in comparative anatomy; and the zoological writer will readily find what proportion of the anatomy of the species under his consideration may be studied in the Museum of the College.

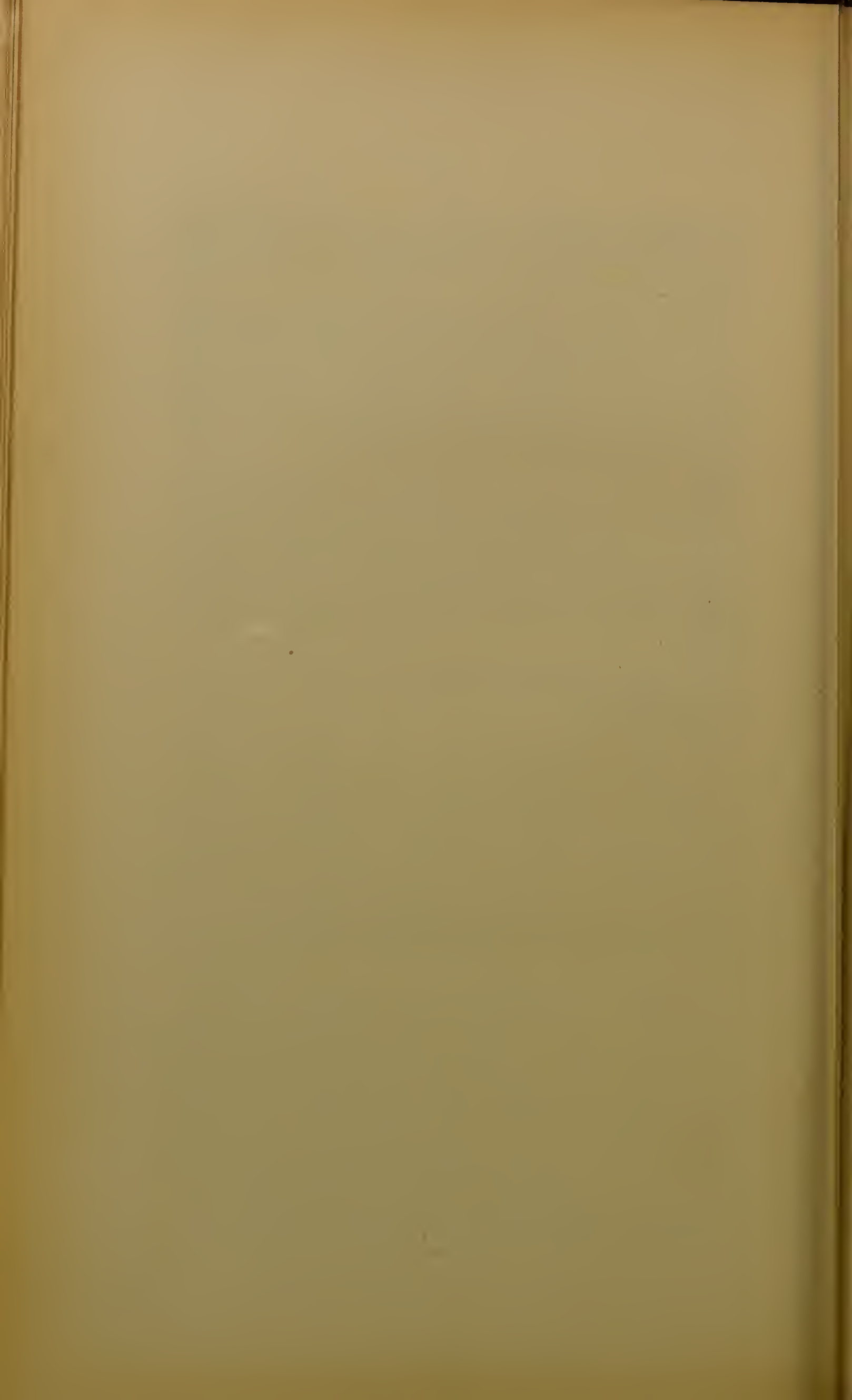
The wishes and the convenience of physiological visitors have been considered in the formation of another index in which the

preparations are classed according to the organs ; under each head reference is made to the number of the preparation in the collection, and to the page of the catalogue in which it is described.

There is, lastly, an alphabetical index of donors, and of other sources, from which the physiological department of the collection has received additions. These additional preparations are marked by the same numbers as the Hunterian specimens which they respectively follow, and are distinguished by an added letter.

The Council have great gratification in acknowledging the unremitting labour which has been for many years bestowed on this great work by Mr. Owen, one of the Conservators, and now Hunterian Professor of comparative anatomy and physiology to the College, to whom its publication has been exclusively confided.

Royal College of Surgeons, London,
8 July, 1841.



PREFACE

TO THE

SECOND EDITION.

THE last edition of the Catalogue of the Physiological Series was completed in 1840. A second edition of the first volume was published in 1852, which however only incorporated the descriptions of new specimens, the old arrangement being retained without revision. Seeing that this edition was carried no further, it seems to me best to consider the present as the Second Edition, as the arrangement is different and a complete revision has been effected.

Since 1840 numerous additions to the Museum have been made, especially by illustrations of Mammalian anatomy. Of these, and all others, there are no descriptions, only the name of the animal from which they are derived being affixed. Many of the preparations of Human Anatomy have been removed to constitute, with additional preparations, a new Series now exhibited in Rooms I. & II.

In the original Hunterian scheme the intention evidently was to bring together examples of such structures in plants and animals as performed the same function. Such structures in plants and lower animals were very imperfectly represented, and many had become useless from the lapse of time. From these and other reasons a revision of the Catalogue has for a long time been a most urgent need. The difficulty of this is great, as a large number of preparations are required to supply the places of those that have become worthless, and to serve as illustrations of new discoveries, and phases of thought. The additions made of late years have mainly been selected with this view, and I have drawn up a provisional scheme as a guide

to a re-arrangement, which, however, will be certain to require modifications when the groups are considered in detail.

The final arrangement of each sub-group is taxonomic, commencing with the lowest plant showing the structure, and ending with man. When chemical composition and development are illustrated, they precede the mature structure. An oval label bearing the Catalogue number characterizes this Series. A capital letter indicates the group. Additions are distinguished by a small letter. When this is placed in front of the number it means that the specimen should be placed in front of the one that bears the number alone, the reverse being the case if the letter follows the number. As in other departments, black figures indicate that the specimen is Hunterian. After many of the descriptions of the specimens references are given, which are selected as being most useful, and in them will often be found the titles of previous papers on the subject.

In carrying out this work I am greatly indebted to the kind assistance of many friends who have most liberally placed at my disposal valuable material that has enabled me to supply many deficiencies; their names are duly mentioned in the Catalogue. More especially do I wish to thank Profs. G. B. Howes, J. B. Farmer, and F. G. Parsons for much valuable aid and advice. The admirable preparations made by Mr. R. H. Burne have enabled me to exhibit preparations of structures of great delicacy and interest, that, as they are prepared by the best modern methods, are likely to be permanent. Mr. W. Pearson's dissections of Vertebrata leave nothing to be desired in the clearness and beauty with which they are displayed. I have also to thank Mr. J. Green, of Mintern Bros., for the excellent manner in which he has reproduced my drawings. It is hoped that they may help to render the Catalogue useful to many, independently of the Museum.

C. STEWART,
Conservator.

25 June, 1900.

SCHEME OF GROUPS, AND DETAILS OF SUCH AS HAVE YET TO BE COMPLETED.

STRUCTURES CONCERNED IN THE PRE- SERVATION OF THE INDIVIDUAL, OR TO ITS ADVANTAGE.

- A. ENDOSKELETON.
- B. FLEXIBLE BONDS OF UNION AND SUPPORT.
- C. MUSCULAR AND ALLIED SYSTEMS.
- D. NERVOUS SYSTEM.
- E. ORGANS OF SPECIAL SENSE.
- F. INTEGUMENTARY SYSTEM AND EXOSKELETON.
- G. LUMINOUS AND ELECTRIC ORGANS.
- H. ORGANS FOR LOCOMOTION AND FLOATING BORING. FIXATION. (Including those of Spores, Seeds, and Fruits.)

Organs concerned in Nutrition.

- I. RESERVE STORES OF FOOD, AND CALORIFIC MATTER (not for Embryo).
- J. ORGANS FOR DIRECT ABSORPTION AND PREPARATION OF FOOD.
- K. NUTRIENT FLUIDS, AND ORGANS THAT PREPARE THEM. (Including "Ductless Glands.")
- L. CIRCULATORY SYSTEM AND BODY-CAVITY (=CÆLOM).

Blood-purifying and Sound-producing Organs.

M. RESPIRATORY SYSTEM.

N. SOUND-PRODUCING ORGANS. (Including Larynx and Syrinx.)

O. URINARY ORGANS. (Including Kidneys, Bladder, and Waste-Products.)

P. SPECIALIZATION AND DIVISION OF LABOUR AMONGST "PERSONS" OR "INDIVIDUALS."

STRUCTURES CONCERNED IN THE PRESERVATION OF THE RACE.

Q. REPRODUCTIVE SYSTEM.

R. STRUCTURES FOR THE PROTECTION OF THE YOUNG. (Including Eggs, Egg-Capsules, Nests.)

S. STRUCTURES CONCERNED IN THE NOURISHMENT OF THE YOUNG. (Including Mammary Glands and Placentæ.)

T. DEVELOPMENT.

U. ALTERNATION OF GENERATION. DIMORPHISM. POLYMORPHISM.

V. SECONDARY SEXUAL CHARACTERS.

W. NORMAL VARIATIONS OF SPECIES.

X. ASSOCIATION OF DIFFERENT SPECIES, WITH OR WITHOUT MODIFICATIONS OF STRUCTURE.

STRUCTURES CONCERNED IN THE PRESERVATION OF THE INDIVIDUAL, OR TO ITS ADVANTAGE.

A.

ENDOSKELETON.

(Including all structures that function as an Endoskeleton, whether derived from Ectoderm, Mesoderm, or Endoderm, or the equivalent embryonic layers.)

A structure specialized to give to the organism support, strength, rigidity, and protection to more deeply seated parts; in some cases it furnishes the levers and fulcra for the movements of parts of the body or advantageous attachment for muscle. Its physical properties are independent of life.

Plants.

The bundles of thick-walled elongated cells commonly associated with the vascular bundles act as an endoskeleton.

Animals.

As spicules, fibres, &c. As cartilage. White fibrous tissue, the bundles closely interwoven to resist strain in any direction, with or without an admixture of yellow elastic tissue. Bone or allied tissue hardened by lime-salts.

After taxonomically arranged endoskeletons is a group of air-containing bones.

B.

FLEXIBLE BONDS OF UNION AND SUPPORT.

VERTEBRAL COLUMN. JOINTS.

Areolar tissue and yellow elastic tissue, connecting and supporting soft parts. Bonds of union between rigid structures, ligaments, &c. Physical properties are independent of life.

C.

MUSCULAR AND ALLIED SYSTEMS.

Protoplasm of plants and animals is contractile, the contraction possibly being chiefly or alone seated in its spongioplasm. In animals alone is a definite muscular system developed. Contraction dependent on life.

D.

NERVOUS SYSTEM.

Consists essentially of cells and fibres. The cells emit and receive nervous impulses ; the fibres conduct them. The cells may be permanently modified by impulses received (memory, instinct).

Functions. The stimulation and regulation of the contractions of the muscular system. By its sensory or afferent nerves making the movements of the body appropriate to its surroundings. Possibly directly influencing nutrition (trophic nerves).

Plants.

The continuity of the protoplasm in *Plants* allows the stimulation at one part to spread and influence neighbouring cells ; the extent of such spreading being in proportion to the intensity of the stimulation. They have no nervous system.

Animals.

(In all forms below the Vertebrata the entire nervous system may be shown ; but in the Vertebrata their usually large size makes a separation into certain groups convenient, as Brain, Spinal cord, Nerves, Sympathetic or Visceral System.)

E.**ORGANS OF SPECIAL SENSE.**

Tactile organs. Gustatory organs. Olfactory organs. Auditory organs. Visual organs. Organs of unknown function.

The fundamental structure of all the organs of special sense, except the visual, is so closely alike or identical, that it is sometimes difficult to determine to which special sense a given structure shall be assigned ; for in their simplest condition they consist of an epithelial cell or cells, each having at its free extremity a stiff process projecting more or less into the surrounding medium (water or air), and at its deep extremity a process continuous with the nervous system. The external process may, when touched, cause an excitation of the cell, when it would be tactile in function ; or by being bathed by some special material in solution it might give rise to the sense of smell or taste : or moved by sound-waves give rise to the sense of hearing. Auditory organs are often combined, or may be confused with organs concerned with equilibration. There is usually little doubt about a visual organ, but some luminous organs have been mistaken for eyes (Euphausia).

Tactile organs.	}	Examples of each arranged in taxonomic order.
Gustatory organs.		
Olfactory organs.		
Auditory organs.		
Visual organs.		
Special sense organs of doubtful function.		

F.**INTEGUMENTARY SYSTEM AND EXOSKELETON.**

The external surface of organisms coming in closest relation with external surroundings is commonly modified in the following directions, viz. :—For the protection of deeper parts. For

sensation. For getting rid of waste products. For adornment. For regulation of temperature, with prevention of undue loss or gain of heat.

Passive resistance to injury (like an armour, like soft padding).

Plants.

By own tissues or secretion from them.

Examples in taxonomic order (epidermis, cuticle, bark, &c.).

Animals.

By own tissues or secretion from them.

Examples in taxonomic order (shells, epidermis, &c.).

By adventitious bodies which may also serve for concealment.

Examples in taxonomic order (case of Caddis larva, &c.).

Offensive resistance to injury, also sometimes used for attack (by spines, horns, &c.).

Plants.

Examples in taxonomic order.

Animals.

Examples in taxonomic order.

Protection against undue loss or gain of heat, and sometimes against injury.

Animals.

By hair, feathers.

By fat (also is a storehouse of food and calorific matter, and its low specific gravity makes the body buoyant in water).

Examples of both taxonomically arranged.

*Colour and Form.***Animals.***Examples of colours due to different causes.**Examples of distribution on different regions of individual.**Examples of different colours in the same group.**Non-significant Colours.**Adornment.**Sexual Recognition.**Protective resemblance.*

By structure of individual.

By adventitious matter.

*Alluring prey.**Warning Colours and Attitudes.**Mimicry.*

Of specially protected by less specially protected species.

Between two species both specially protected.

*(Examples of all the above to be in taxonomic order under their respective headings.)**Changes of Form, Colour, in the same individual or species.*

Associated with Season.

Sexual maturity (recurrent).

Sexual atrophy.

Food.

Light and Heat.

Unknown cause.

Examples under each head arranged taxonomically.

SPECIAL GLANDS AND SECRETIONS, not mammary or lachrymal, but including anal glands and poison-glands, both buccal and cutaneous.

In all cases the secretion may be a means of getting rid of waste or injurious matter.

The gland may consist of one cell (unicellular gland), or many lining an inpushing of the surface.

Wax- and Oil-glands. Functions: to protect from enemies; to prevent wetting or evaporation; and to keep the surface supple and lubricated.

Mucous Glands. Function to lubricate.

Scent-Glands. Functions: offensive; for recognition; erotic.

Sweat-Glands. Function: excreting a watery fluid, whose evaporation cools the body.

Pigment-Glands. Function: secretion to conceal from enemies.

Poison-Glands. Functions: defence, offence, and killing prey.

G.

LUMINOUS AND ELECTRIC ORGANS.

Luminous Organs.

Plants.

Many plants show a diffused luminosity varying somewhat in intensity in different regions, but no special organs for the production of light are known.

Animals.

In animals the production of light is usually limited to special parts or organs.

Examples taxonomically arranged.

Electric Organs.

Alone present in animals, and are formed by a modification of portion of the muscular and nervous systems.

Animals.

Examples taxonomically arranged.

H.

ORGANS FOR LOCOMOTION AND FLOATING.
BORING. FIXATION.

(Including those of Spores, Seeds, and Fruits.)

At some period in the life of all organisms they are fitted to change their locality, either by their own spontaneous motion ; by becoming attached to other motile bodies ; or by being carried by currents in air or water. This change of place is necessary in *all* to prevent overcrowding, and in most for obtaining food, seeking members of the opposite sex, avoiding inimical conditions, or obtaining fresh shelter.

1. *Locomotion on Solids.*

The mechanism of locomotion on solids is the same in water and air, on *semi*-solids in water the locomotion is the same as on solids in air ; the animal receiving more support from water, so that it will not sink when moving on submerged mud or sand.

CREEPING.

Movement usually slow, with generally a large surface in contact with the ground. Not effected by paired jointed appendages, although they may be used for grasping (this character is artificial but convenient).

By contraction at one part forcing fluid protoplasm to the opposite relaxed side ; this results in a flowing movement from the contracting to the relaxed regions, which are driven forwards as root-like processes (pseudopodia).

Plants.

Example. Myxomycetes.

Animals.

Example. Rhizopoda.

Due to minute waves of contraction of ventral surface or other part of the body-wall, passing in the direction of motion, usually from behind forwards.

Animals.

Examples. Anthozoa : Dianthus.
 Bryozoa : Cristatella.
 Gastropoda : Helix.

Motion effected by extensions and contractions of the whole body, a special process of it, or of successive segments.

Examples. Annelida.
 Echinodermata : Asteroidea, &c.
 Pelecypoda.
 Ophidia.

By loop action. The body being extended, the anterior end is fixed ; the opposite extremity is then drawn up to it and fixed, the body being looped ; the extension of the body and fixation of the anterior end is then repeated.

Examples. Hydrozoa : Hydra.
 Annelida : Hirudo.
 Insecta : Larvæ of Lepidoptera, Geometrina.
 Gastropoda : Xenophora.

By undulatory movements, or by appendages.

Examples. Annelida.
 Reptilia : Ophidia.

WALKING AND RUNNING.

Body more or less raised on processes of the body, or jointed limbs, which effect the locomotion by pulling, pushing, or usually both.

Examples. Infusoria : Hypotricha.
 Hydrozoa : Planoblast of Clavatella.
 Crustacea.
 Myriapoda.

Insecta : Coleoptera, &c.
 Pisces : Trigla.
 Amphibia.
 Reptilia.
 Aves.
 Mammalia.

LEAPING.

Organism projected more or less from surface on which it rests, by sudden extension of special structure or its whole body.

Plants.

Examples. Spores of certain Fungi.
 Spores and Elaters of Hepaticæ.
 Spores of Equisetaceæ.
 Suddenly bursting fruits.

Animals.

Examples. Crustacea : Gammarus, &c.
 Arachnida : Hunting-Spider.
 Insecta : Petrobius, Podura, Locusta, Larva of Cheese-fly.
 Pelecypoda : Cardium.
 Gastropoda : Strombus.
 Pisces ?
 Amphibia : Rana.
 Reptilia : Snake.
 Aves : Sparrow, &c.
 Mammalia : Kangaroo, Jerboa, &c.

2. *Climbing and Prehension.*

Excluding such as are concerned in Direct absorption, or used chiefly for Creeping. Nearly all creeping animals can climb, as they firmly cling to the support from which their bodies are not much raised.

Many plants which, owing to their slender and weak stems, could not otherwise raise themselves high into the air, or ascend vertical rocks, &c., are enabled to do so by their stems, or special structures borne by their stems, either twining around the

stronger branches of other plants, grappling their support with hooks, or by sucker-like structures. The plant is *fixed*, growth alone causing the growing end to ascend; but it is thought convenient to consider such structures here, as they closely resemble the prehensile and climbing organs of animals.

The seeds and fruits of many plants are dispersed by hooks or spines which they bear getting entangled amongst the hairs of animals.

*Effected by Hooks: Grasping and Twining: or by Suckers
(often combined).*

BY HOOKS.

Plants.

Examples. Vegetative portion, Rose.
Climbing-palm.
Seeds and Fruits.

Animals.

Examples. Arthropoda: many?
Reptilia: Iguana, &c.
Mammalia: Sloth, Cat, Bat, &c.

BY TWINING.

Plants.

Examples. Hop, Ipomœa, Vine, &c.

Animals.

Example. Ophiuroidea.

BY GRASPING

Animals.

Examples. Antedon.
Rotifera (by "toes").
Crustacea: Birgus.
Reptilia: Chameleon.
Aves: Parrot.
Mammalia: Monkeys, &c. &c.

BY SUCKERS OR ALLIED STRUCTURES.

Plants.

Examples. Ivy, Virginian-creeper.

Animals.

Examples. Arachnida : Hunting-Spider.

Insecta : many by pulvilli.

Entozoa : Tænia.

Crustacea : Argulus.

Cephalopoda.

Pisces : Echeneis, &c.

Amphibia : Hyla.

Reptilia : Gecko.

Mammalia : Chiroptera (Thyroptera).

3. *In Semi-solids (Earth, Mud, Sand).*

All burrowing animals derive shelter by this habit ; by it also many obtain their food.

BURROWING.

Plants.

Examples. Seeds of some Grasses.

Animals.

By extensions and contractions of the whole or a part of the body.

Examples. Annelida : Lumbricus.

Pelecypoda : Solen.

Enteropneusta : Balanoglossus.

By undulations or rotations of axis of body.

Examples. Pisces : Eel.

Amphibia : Gymnophiona.

Reptilia : some Ophidia.

By Spines.

Example. Echinodermata : Spatangus.

By Limbs.

Examples. Crustacea.

Insecta : Gryllotalpa.

Mammalia : Edentata, Talpa.

By Teeth.

Example. Some Rodentia.

4. *Locomotion and resting on Semi-solids (Mud, Sand, Snow) and on Floating Bodies.*

The supporting surface of the animal is relatively great. The expansion also often serves for other purposes.

Animals.

Examples. Porifera : some.

Aves : Jacari.

Mammalia : Camel, Lagopus, &c.

5. *Free in and on Water.*

Body made buoyant by gas or water, with increased resistance to sinking by extension of surface. Associated in some with greasy or waxy condition of surface, which prevents wetting.

FLOATING.

Plants.

Most plants and parts of plants will float owing to the low specific gravity of cellulose and the large amount of gas and water commonly contained in their tissues. Only such plants as are *specialized* for floating are included here.

Examples. Algæ : Sargassum ; some Diatomaceæ, many Phanerogams.

Animals.

Examples. Rhizopoda : Globigerina, many Radiolaria.

Hydrozoa : Physalia, Porpita, Velella.

Anthozoa : Minyas.

Bryozoa : Statoblasts.

Crustacea : Lepas.

Gastropoda : Ianthina.

SWIMMING.

By Cilia and Flagella.

Plants.

Examples. Spores of certain Algæ.
Spores of certain Fungi.

Animals.

Examples. Infusoria.
Radiolaria : some.
Ctenophora.
Turbellaria.

By Expulsion of Water from a chamber whose walls are suddenly approximated, or by appendages suddenly approximated.

Animals.

Examples. Hydrozoa : Medusæ, Siphonophora.
Echinodermata : Antedon.
Insecta : Larva of Libellula.
Pelecypoda : Pecten.
Cephalopoda.
Urochorda : Salpa, Doliolum.

By wave-like undulations or bendings of the whole or part of the body, and not by paired appendages.

Animals.

Examples. Leech.
Sagitta.
Gastropoda : Carinaria, Pterotrachea.
Urochorda : Appendicularia.
Pisces : some ?
Amphibia.
Reptilia : Hydrophis.

By Paired Appendages alone, or combined with flexions of body.

Animals.

Examples. Crustacea : Portunus, &c.
Arachnida : Hydrachna, &c.
Insecta : Hydrous, Water-skaters.

Pteropoda.
 Pisces.
 Amphibia : Rana.
 Reptilia : Chelone.
 Aves : by legs, by wings.
 Mammalia.

6. *Free in Air.*

Passive. Carried by currents.

Adapted by minute size and lightness, with investment resisting drying.

Plants.

Examples. Spores of Lycopodon, &c.

Animals.

Examples. Rotifera : Infusoria, &c. (encysted).

Adapted by expansion of surface, increasing resistance to falling (parachute action).

Plants.

Examples. Many Seeds and Fruits.

Animals.

Examples. Arachnida : Lycosa.
 Pisces : Flying-fish.
 Reptilia : Flying-Gecko, Flying-Dragon.
 Mammalia : Flying-Fox, &c. &c.

Active. Some portion of the expanded surface being actively moved (=true flight).

Animals.

Examples. Insecta.
 Reptilia : Pterosauria.
 Aves : Archæopteryx ; birds generally.
 Mammalia : Chiroptera.

7. *Boring in and Removal of Solids.*

For shelter, or to increase capacity of shell &c. Not for obtaining food, for which see Section J.

Plants.

Examples. Some Algæ and Fungi.

Animals.

Examples. Porifera : Cliona.

Echinodermata : Strongylocentrotus lividus.

Annelida.

Crustacea : Eupagurus.

Pelecypoda : Pholas, Saxicava, Teredo.

Gastropoda : Patella, Nerita, Conus.

8. FIXATION.

Exclusive of such as are used for Climbing or Direct Absorption by Plants.

On Solids.

Plants.

Example. Algæ : Laminaria.

Animals.

Examples. Rhizopoda, by moulding of shell to support.

Infusoria : Vorticella.

Porifera.

Hydrozoa, by hydrorhiza.

Anthozoa, by expanded base.

Crustacea : Cirripedia.

Bryozoa.

Brachiopoda.

Pelecypoda : Oyster, Mytilus, Anomia.

Gastropoda : Vermetus.

Urochorda : Ascidia.

On Semi-solids.

Animals.

Examples. Porifera : Hyalonema.

Hydrozoa ?

Anthozoa : Cerianthus ?, Pennatula.

Brachiopod : Lingula.

Organs concerned in Nutrition.

I.

RESERVE STORES OF FOOD, AND CALORIFIC MATTER (not for Embryo).

Plants.

Examples. As Starch in Stem : Potato, Sago-palm, &c.
Inulin : Dahlia.
Sugar : Beetroot, &c.

Animals.

Examples. As Oil : Fatty bodies of Amphibia, Reptilia.
Glycogen : in mantle-lobes of Mollusca, and Liver.

J.

ORGANS FOR DIRECT ABSORPTION AND PREPARATION OF FOOD.

Plants.

Most plants absorb their food in a fluid or gaseous form. By their roots (also used for fixation) they chiefly absorb water holding in solution mineral salts and compounds of nitrogen. By their leaves, or, in some cases, by their stems, the gases.

Bacteria in the soil greatly increase the vigour of plants, by changes they produce in the organic constituents of the humus.

Examples of Roots arranged taxonomically.

Animals.

Many parasites that live with the whole or a part of their bodies bathed by the nutrient juices of their hosts are nourished by the direct absorption of such juices, and possess no digestive or circulatory apparatus.

Examples. Infusoria : Opalina.
Gregarinidæ : Gregarina, &c.
Cestoidea Tænia.
Crustacea Sacculina.

When the food in part consists of solid or non-diffusible matter, the solids have to be dissolved and the proteids have to be made diffusible by being turned into peptones ; the fats have to be emulsified or saponified ; and the starch turned into sugars before absorption can take place. This change is effected in special chambers or parts, and constitutes the act of digestion.

Plants.

Examples. By folded leaf : *Drosera*, *Pinguicula*.

By pitchers : *Nepenthes*, *Cephalotus*, *Utricularia*.

Animals.

The entire alimentary canal, with its glands and mouth-appendages.

Invertebrata.

Taxonomically arranged.

Vertebrata.

Mouth-organs : used for prehension, mastication, insalivation, and deglutination.

Œsophagus and Stomach.

Liver and Pancreas.

Small Intestine.

Large Intestine, Cæcum, and Rectum.

In each case the nature of the food to be stated. In many specimens, parts other than those specified in the sub-group may be shown.

K.

NUTRIENT FLUIDS, AND ORGANS THAT PREPARE THEM.

(Including "Ductless Glands.")

Sap ; Blood ; Lymph ; Blood and Lymph elaborating organs.

Plants.

The sap of plants is a structureless fluid, found in the cell-walls and intercellular spaces (ordinary sap), or in the interior of the cells (cell-sap). It consists of water chiefly absorbed by

the roots, holding in solution inorganic salts derived from the soil, and organic matter (sugar, &c.) formed by the plant.

Chlorophyll-containing organisms (mostly plants) are almost alone amongst living things capable of combining inorganic matter to form organic. Some bacteria are also said to do this.

The sap is to the plant much the same as blood to the animal.

Animals.

Blood. A coagulable fluid containing formed elements = blood-corpuscles. May be colourless or nearly so, as in most Arthropoda, Mollusca, Urochorda, and Cephalochorda. Red from presence of Hæmoglobin in liquor sanguinis, as in Annelida, and Planorbis amongst Gastropods. Red from presence of Hæmoglobin in corpuscles in Solen legumen and Arca amongst the Pelecypoda, and Vertebrata generally. Rose-violet in Lingula. Blue when the copper-containing body, Hæmocyonin, is present, as in Cephalopoda, Arachnida, and Crustacea.

Functions. The diffusion of nutriment and oxygen, with the removal of waste products from the tissues in all. In some it also diffuses heat, and may effect the erection of certain organs or serve for adornment.

Examples. Buffy coat, &c.

Lymph. Mostly a colourless fluid exuded from the blood-vessels into the tissues; it becomes corpusculate after passing through the lymphatic glands, and is returned to the venous blood. The lymphatics in the walls of the alimentary canal have commonly milk-like contents due to absorbed emulsified fats, &c.; they are hence called Lacteals.

“Ductless Glands”—Blood and Lymph elaborating Organs.

Not consisting of Cytogenous-Adenoid Tissue.

Chief cells derived in many cases, at least in part, from diverticula of alimentary canal. They lie outside the blood-current.

Examples. Pineal gland. } See Brain.
Pituitary body. }
Thyroid gland.
Adrenals = Supra-renal capsules.

Consisting chiefly of Cytogenous Tissue.

Cytogenous tissue consists of a sponge-like network of cells, whose meshes are occupied by small rounded cells. Masses of this tissue are found in many parts of the body, especially in the walls of the alimentary canal. Red blood-corpuscles are also thought to be in part formed in certain connective-tissue corpuscles of the embryo, and in the red marrow of bones.

Placed in the path of the Lymph, elaborating and adding cells to it.

Examples. Tonsils.

Thymus. (Hassel's corpuscles derived from alimentary canal.)

Lymphatic glands.

Placed in the path of the Blood, elaborating it, adding new corpuscles, and destroying old ones. The lymphatics are here continuous with the blood vascular system.

Example. Spleen.

L.

CIRCULATORY SYSTEM AND BODY-CAVITY (=CŒLOM).

Plants.

The sap of vascular plants is mainly conducted by their fibro-vascular bundles (wood, &c.). The causes of its movements are : the osmotic absorption of fresh material by the roots forcing upwards that already in the plant (=root-force); the evaporation from leaves and other parts drawing upwards the sap below ; the demand for fresh material by growing parts, these abstract from the sap the materials required for their growth, a constant diffusion current must take place between the sap deprived of such materials and the sap still containing them.

Examples showing arrangement of vascular bundles in taxonomic order.

Animals.

In the young vertebrate embryo the first direction of the blood-flow is from the food-containing structures (umbilical vesicle, food-yolk) towards the body. It is due to the demand

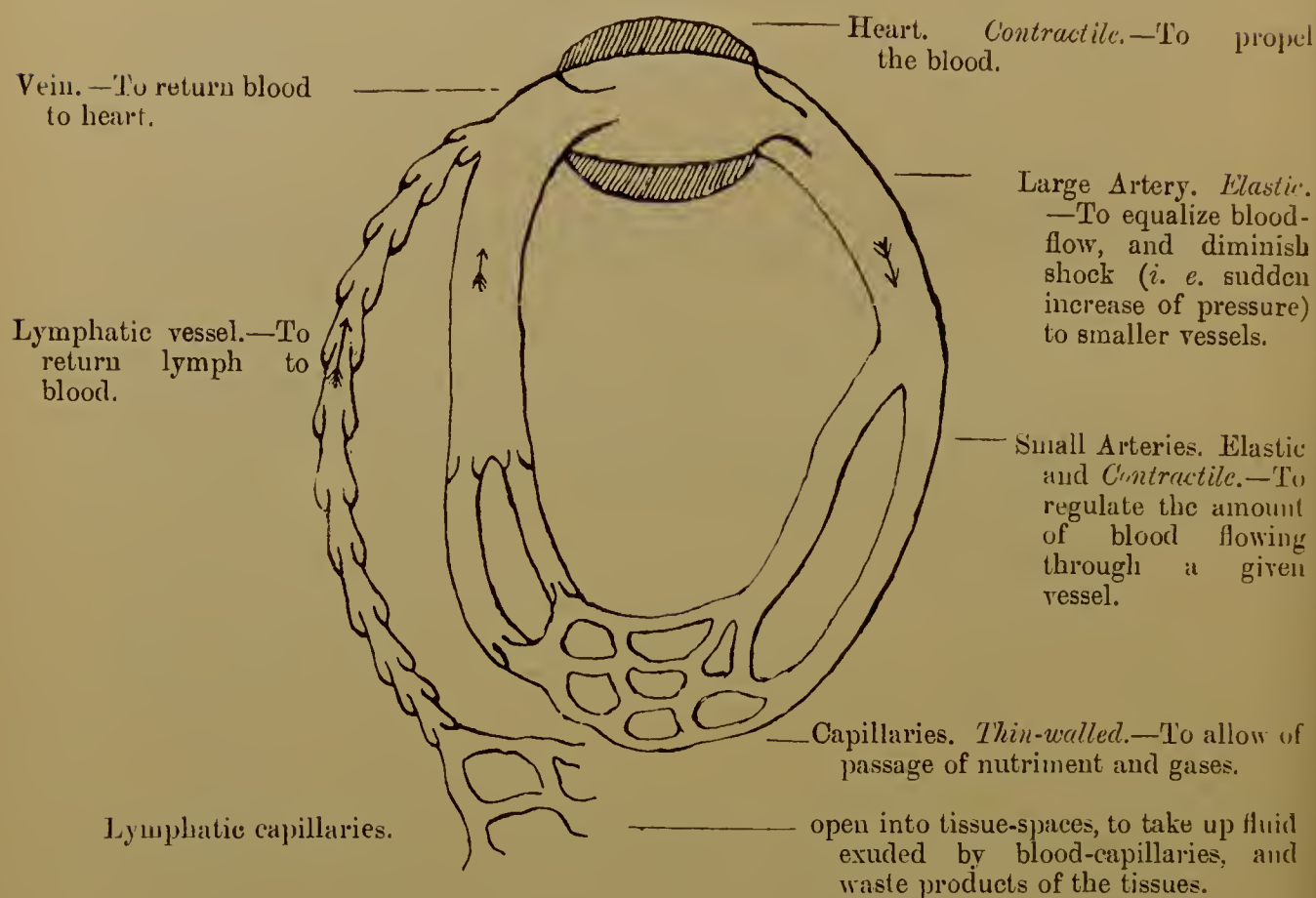


DIAGRAM OF CIRCULATION.

for formative material by the embryo, and its absorption from the food-yolk. The heart as a blood-propelling structure is a secondary cause of the circulation.

In the adult the causes of the circulation are: the contraction of the Heart, and the demand for fresh material by the tissues: these forces bring the blood to the tissues. The return of the blood to the Heart is the result of the passage of the blood from the capillaries (through whose walls the nutrient fluid and gases pass) into the veins; intermittent pressure by the tissues on the veins squeezing the blood towards the Heart, as valves whose edges are directed towards that organ prevent a backward flow: and the suction action of the dilating heart and chest.

The circulation of the Lymph is mainly due to the same causes as those of the blood in the veins, with, in addition, the suction action of the venous blood where that fluid rushes by the orifices by which the lymphatics open into the veins.

In some animals (*e. g.* Frogs) the lymphatics have muscular contractile chambers (lymph-hearts) which assist in propelling the lymph.

Examples of the circulatory system arranged in taxonomic order, with division into anatomical groups.

Serous cavities might be placed here.

Blood-purifying and Sound-producing Organs

M.

RESPIRATORY SYSTEM.

Carbon dioxide, the common waste-product of tissue change, and of the decomposition and oxidation of carbo-hydrates (starch, sugars) and hydro-carbons (fats), is removed from the organism either at the non-specialized general surface, or by more or less special respiratory organs. At the same time that CO₂ is given out Oxygen is absorbed.

Plants.

The respiration of Chlorophyll-containing plants when exposed to light is masked by the CO₂ being used as a food-material—the CO₂ being decomposed, the carbon used in the formation of starch (C₆H₁₀O₅), and the oxygen given out. In the dark CO₂ is given off. There are no special organs for respiration.

Animals.

In Water. The necessary special surface for respiration in water is generally in the form of fringe-like projections (*e. g.* Branchiæ, Gills).

Examples taxonomically arranged.

In Air. The special surface is generally in the form of inpushings (*e. g.* Tracheæ, Lungs, &c.).

Examples taxonomically arranged.

In Water and Air. A combination of the two special structures usually present, or a special arrangement to prevent the gills drying.

Examples. Crustacea : Birgus latro.

Gastropoda : Ampullaria.

Pisces : Ceratodus, Amia, &c.

Many fish habitually swallow air, which yields up its oxygen in exchange for the CO₂ in the blood in the vessels of the alimentary canal, thus supplementing the respiration by gills.

N.

SOUND-PRODUCING ORGANS.

(Including Larynx and Syrinx.)

Used by animals for signalling their presence, to give warning of danger, and exciting sexual passion.

Not Larynx or Syrinx.

Examples. The simplest and least-specialized in each class to commence the series.

Crustacea.

Arachnida.

Myriapoda.

Insecta.

Reptilia.

Mammalia.

Larynx and Syrinx.

Examples taxonomically arranged.

O.

URINARY ORGANS.

(Including Kidneys, Bladder, and Waste Products.)

Chief duty the removal from the body of waste nitrogenous matter (as Urea and Urates) and surplus water.

The cells that excrete this product are usually derived from those which line the body-cavity.

Examples taxonomically arranged. They will sometimes include the reproductive organs.

P.

SPECIALIZATION AND DIVISION OF LABOUR
AMONGST "PERSONS" OR "INDIVIDUALS."

A mass of non-specialized protoplasm can perform all the essential functions of life ; it can move, take in food and digest it, grow by forming its own substance out of absorbed food which was originally unlike itself (a function peculiar to living matter), and can by division increase in number (*e. g.* Rhizopoda). In the Infusoria different layers of the protoplasm are specialized to perform particular functions.

The higher forms of animals (Metazoa) are composed of numerous associated units (cells), each like the entire body of a Rhizopod, and of tissues specialized to perform one function, derived from such cells. We have here in the Metazoa a division of labour amongst the cells and tissues.

In the following examples we find a further division of labour, certain semi-independent or independent "persons" produced by budding from the organism resulting from the development of *one* egg ; or the different members of a colony of "individuals" take on the chief or exclusive performance of one function.

This division of labour is of the same advantage to the members of a colony, as results from the special trades of civilized life.

*Persons.***Plants.**

Examples. Many commonly considered as organs.

Animals.

Examples. Hydrozoa.
 Anthozoa.
 Cestoidea.

Individuals.

Examples. Insecta : Termes, &c.

STRUCTURES CONCERNED IN THE PRE- SERVATION OF THE RACE.

Q.**REPRODUCTIVE SYSTEM.**

All animals are directly or indirectly dependent upon plants for their food ; and all plants and animals die from accident, disease, or natural decay. If they did not reproduce themselves all living organisms would become extinct. This is effected by the Reproductive System.

Asexual.

By budding, fission, spores.

Plants.

Examples taxonomically arranged.

Animals.

Examples taxonomically arranged.

*Sexual—Hermaphrodite.***Plants.**

Examples. Monœcious : Dichinous.

Animals.

Examples taxonomically arranged.

Sexual—Male.

Examples taxonomically arranged.

Sexual—Female.

Examples taxonomically arranged.

R.

**STRUCTURES FOR THE PROTECTION OF THE
YOUNG.**

(Including Eggs, Egg-Capsules, Nests, &c.)

Plants.

Examples. Fruits.

Animals.

Examples taxonomically arranged.

S.

**STRUCTURES CONCERNED IN THE NOURISH-
MENT OF THE YOUNG.**

(Including Mammary Glands and Placentæ.)

Plants.

Examples. Endosperm : Perisperm.

Animals.

Examples. Yolk.

Mammary glands. Placentæ.

Taxonomically arranged.

T.

DEVELOPMENT.

Plants.

Examples. Germinating Seeds, &c.

Animals.

Examples taxonomically arranged.

U.

**ALTERNATION OF GENERATION. DIMORPHISM.
POLYMORPHISM.**

Plants.

Animals.

V.

SECONDARY SEXUAL CHARACTERS.

Characters which distinguish the sex, and that are not directly concerned in reproduction.

Plants. }
Animals. } *Examples* taxonomically arranged.

Sexual dimorphism.

W.

NORMAL VARIATIONS OF SPECIES.

Living in the same locality.

Examples taxonomically arranged.

Living in different localities.

Examples taxonomically arranged.

X.

**ASSOCIATION OF DIFFERENT SPECIES, WITH
OR WITHOUT MODIFICATIONS OF STRUCTURE.**

Commensalism.

Association of two species, from which one (the guest) constantly found so associated derives advantage without injuring its host.

Examples arranged according to taxonomic position of guest.

Symbiosis.

Association of two or more species for the advantage of all.

Examples arranged according to taxonomic position of dominant form.

Parasitism.

Association of two species, of which one, the guest, derives advantage at the expense of the other, its host.

Examples arranged according to taxonomic position of guest.

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DESCRIPTIVE CATALOGUE
OF THE
PHYSIOLOGICAL SERIES.

*STRUCTURES CONCERNED IN THE PRE-
SERVATION OF THE INDIVIDUAL OR
TO ITS ADVANTAGE.*

A.
ENDOSKELETON.

(Including all structures that function as an Endoskeleton, whether derived from Ectoderm, Mesoderm, or Endoderm, or the equivalent embryonic layers.)

A structure specialized to give to the organism support, strength, rigidity, and protection to more deeply seated parts; in some cases it furnishes the levers and fulcra for the movements of parts of the body or advantageous attachment for muscle. Its physical properties are independent of life.

PLANTS.

The bundles of thick-walled elongated cells commonly associated with the vascular bundles act as an endoskeleton.

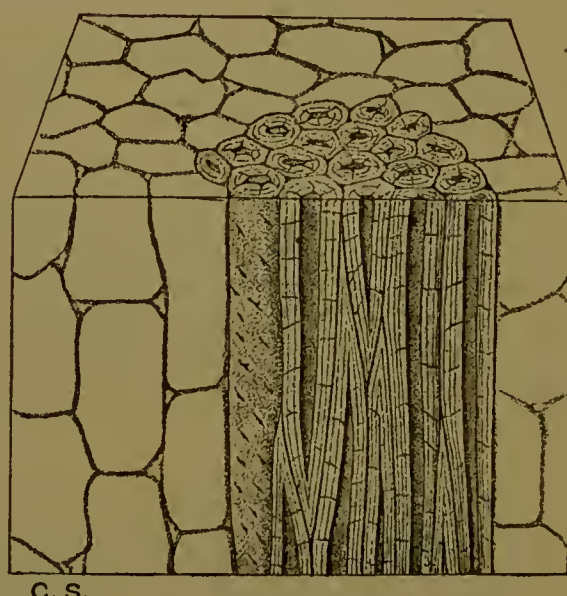
The cell-walls of the whole or greater part of a plant may be hardened by lime (especially when exposed to violent waves, *e. g.* certain Algæ = Corallines) or silex (as in grasses and horse-tails), so as to give the necessary strength and rigidity. These cannot be regarded as *specialized endoskeletons*.

- A. 1. A Red Sea-weed (*Delesseria sanguinea*). The perennial stem-like portion of the thallus has its cells crowded with reserve food-material in the form of aleurone grains. It gives origin in the spring to leaf-like structures that die off in the autumn. Each has an axial bundle of somewhat elongated cells from which other bundles diverge and branch. They are thought to give some extra strength to this portion of the thallus, and serve as special paths for conduction of nutriment. The resemblance to the "veins" (vascular bundles) in true leaves is very great.

Potter, J. Marine Biol. Assoc., vol. i. 1889, p. 171.

- A. 2. Transverse section of the stem of a Tree-fern (*Cyathea dregei*). On the inner and outer side of each vascular bundle is a flattened bundle of almost black, greatly elongated (prosenchymatous), thick-walled cells derived from the fundamental tissue (=tissue between epidermis on the outside and vascular bundles in the interior). The increased thickness of the walls of these cells is due to a

Fig. 1.



× 110.

secondary deposit of lignone, which renders them hard and stiff. This form of tissue is known as "Sclerenchyma"; it gives strength and stiffness to the stem. The drawing shows the structure of the sclerenchyma. (Fig. 1.)

- A. 3. Sections of the stem of a Wax-palm (*Copernicia cerifera*), with a drawing illustrating its structure. On the phloem (usually outer) side of each vascular bundle is a bundle of thick-walled prosenchymatous cells of dark colour forming a sclerenchyma that gives strength and stiffness to the stem. In the flower-stem each vascular bundle is completely surrounded by a sclerenchymatous sheath.

Micheels, Mém. Cour. Acad. Belgique, t. liii. 1893, p. 1.
Bot. Centralbl., vol. lix. p. 186.

- A. 4. Transverse section of the stem of Black Ebony (*Diospyros melanoxylon*). The outer portion of the wood (alburnum) is of a pale colour and is concerned in the conduction of sap. The central older "heart-wood" (duramen) is of a dark colour, and has ceased to conduct sap. It serves to give extra stiffness and strength to the stem.

- A. 5. Section of stem, portion of leaf, and drawings illustrating the structure of the sclerenchymatous spicular cells, and their arrangement in the leaf of *Welwitschia mirabilis*. In

Fig. 2.



C. S.

Arrangement of Spicular Cells in Leaf of *Welwitschia*.

Vert. long. sect. $\times 20$.

this plant, as in many others, certain cells of the fundamental tissue (=tissue between epidermis and vascular bundles) depart from the usual character of the funda-

mental tissue, becoming greatly elongated and often branched. Their walls are thickened by a secondary deposit of lignone ($C_{12}H_{18}O_9$) on the inner side of the primitive cell-wall formed of cellulose ($C_{12}H_{20}O_{10}$). Numerous crystals of calcium oxalate are imbedded in the outer surface of these cells. The spicular cells appear to confer some extra strength and stiffness to the parts in which they are present. They may also render the plant distasteful to animals; and perhaps serve as a mode of disposal of redundant carbohydrates. (Fig. 2.)

Royal Gardens, Kew.

Hooker, Trans. Linn. Soc., vol. xxiv. 1864, p. 1.

ANIMALS.

PORIFERA.

- A. 6.** A Calcareous Sponge (*Grantia compressa*). Its soft parts are supported by definitely arranged calcareous spicules whose forms are shown in the drawing. Each spicule is formed in one of the cells of the mesoderm. In this sponge they consist of calcium carbonate, having the crystalline structure and other properties of calcite; the form, however, is organic.

Presented by Prof. C. Stewart.

- A. 7.** A Siliceous Sponge (*Craniella* [*Tethya*] *cranium*), belonging to the Sub-Class Tetractinellida. The spicules do not fuse; they are composed of colloid silica in layers around a delicate central cavity occupied by organic matter. The large spicules (megascleres) are mostly arranged in bundles radiating from the centre of the sponge and projecting slightly on its surface. Minute flesh-spicules (microscleres) are also present.

Presented by Prof. C. Stewart.

- A. 8.** Half of a Siliceous Sponge (*Corallistes noli-tangere*. Sub-Class Tetractinellida). The soft tissues and loose spicules have been removed, leaving only the main skeleton. It consists of branched solid spicules (desma) that are

inseparably interlocked by short clubbed or mushroom-shaped processes at the ends of the branches. They are also held together by processes that firmly wrap around and grasp neighbouring spicules. The loose spicules (dichotricenes) that support the dermal membrane, and those forming the main skeleton, are of large size (megasccleres). The minute flesh-spicules (microsccleres) are of two sorts, stellate or bistellate with blunt rays (chiasters or amphiasters), and style-shaped (styli), that is blunt at one end and pointed at the other. A drawing illustrates the forms of the spicules.

Presented by B. W. Priest, Esq.

Sollas, Chall. Rep., vol. xxv. p. 339.

- A. 9. A Siliceous Sponge (*Euplectella aspergillum*. Sub-Class Hexactinellida). The siliceous spicules are six-rayed (hexactinellid). Those that form the main supporting framework are united by bars of silex (synapticulæ) secreted by neighbouring cells. The magnified forms of some of the spicules that always remain free are shown in a drawing.

Presented by Prof. C. Stewart.

- A. 10. A Horny Sponge (*Dendrilla rosea*) with drawings illustrating the structure and mode of development of its fibres, they being secreted by investing cells known as sponginblasts; the material they secrete as spongin.

von Lendenfeld, Zeitschr. wiss. Zool., Bd. xxxviii. 1883, p. 285.

- A. 11. A Horny Sponge (*Euspongia officinalis*), with drawing.

- A. 12. A Horny Sponge (*Dysidea fragilis*), with drawing. Sand-grains coming in contact with the growing ends of the horny fibres adhere to them, and become invested by a thin layer of the same material. The amount of sand varies greatly with the locality; this specimen was obtained off Hastings.

Presented by B. W. Priest, Esq.

Schulze, Zeitschr. wiss. Zool., Bd. xxxii. 1879, p. 130.

HYDROZOA.

The supporting framework (corallum) of the following forms is secreted by the outer layer of the body (ectoderm) upon its external surface. It is accordingly outside the body, but since the latter remains closely investing and surrounding the corallum the coral functions as an internal support to the animal. The endoderm in many forms a cartilage-like support to the arms. The "supporting lamella" and mesogloea likewise serve for support.

- A. 13.** Calcareous corallum of *Millepora alcicornis* (Order Hydrocorallinæ), and drawings illustrating its structure. The corallum is secreted by the outer layer of cells (ectoderm) of a network of tubes (hydrorhiza), and a continuous layer of such cells on the outer surface of the coral. The hydrorhiza gives origin by budding to two sorts of zooids, which can be retracted into tubular chambers (calicles). The lower portion of the calicles are not occupied by the zooid, and are cut off by successively formed plates (tabulæ). Only that portion of the *Millepora* superficial to the last-formed tabula is living. The interior of the hydrorhiza-tubes are filled with a symbiotic alga (*Zooxanthella infestans*) in the form of small round yellow cells, having a well marked cell-wall: they are quite free.

Moseley, Phil. Trans., vol. clxvi. 1877, p. 91.

In the following diagrams the colours represent—Black or White = Corallum; Brown = Ectoderm; Blue = Mesoderm; Green = Endoderm.

- A. 14.** Calcareous corallum of *Stylaster roseus* (Order Hydrocorallinæ), and diagram showing its structure. The corallum is secreted as in the former specimen. The arrangement and shape of the calicles of the dactylozooids as a circle of flattened wedge-shaped chambers surrounding a central deeper and larger calicle in which the gastrozooid is lodged, gives this coral a close superficial resemblance to an *Oculina* (Class Anthozoa). A style-like process of the

coral at the base of the zooids simulates the columella of the Anthozoan. Pl. I. fig. 1.

Moseley, Phil. Trans., vol. clxix. 1879, p. 449.

ANTHOZOA.

Chemical Composition.

The coral is in most cases composed of calcium carbonate associated with a varying amount of organic matter; minute traces of other salts are present. In some Gorgonacea (e. g. *Gorgonia flabellum*, *G. setosa*) calcium phosphate is the chief inorganic constituent of the axis, although none is found in the crust.

- A. 15. Horny axis of *Antipathes politum*. It has been macerated in acid : this has caused a partial separation of its constituent lamellæ. O. C. 85 g.
- A. 16. Small portion of Organ-pipe Coral (*Tubipora musica*). It has been treated with dilute nitric acid which has removed all colour, and the calcium carbonate that alone renders the coral stiff and hard. The polyps may be seen at the mouths of the tubes. O. C. 84. *Hunterian.*
- A. 17. A similar specimen in which the tubes are somewhat larger and the polyps absent. O. C. 85. *Hunterian.*
- A. 18. The axis of a main stem of a Coral (*Melitodes ochracea*). The lower portion has had its surface acted upon by dilute hydrochloric acid. This has partly removed the calcium carbonate, leaving the organic matter. In the "nodes" the organic matter is more abundant: they accordingly project above the level of the more eroded internodes, which are of a bright red colour. Besides the calcium carbonate there is a small trace of calcium phosphate. O. C. 85 A.
- A. 19. Smaller branches of the same Coral (*Melitodes ochracea*) similarly treated. O. C. 85 B.

*Structure and Mode of Formation.**Continuous, non-spicular.*

- A. 20.** *Caryophyllia profunda*, one in section and the other entire, as an example of a simple aporous Coral, with diagram. The sea-anenome-like polyp first secretes upon the rock to which it is attached a disc-like basal plate; radiating ridges on the upper surface of this enlarge to constitute the septa, an extension of the outer ends of these grow together to form the theca, and an elevation in the centre is known as the columella. The corallum, although external to the polyp, functions as a deep-seated support. Pl. I. fig. 2.

G. v. Koch, Mitth. Zool. Stat. Naples, Bd. xii. 1897, p. 767.

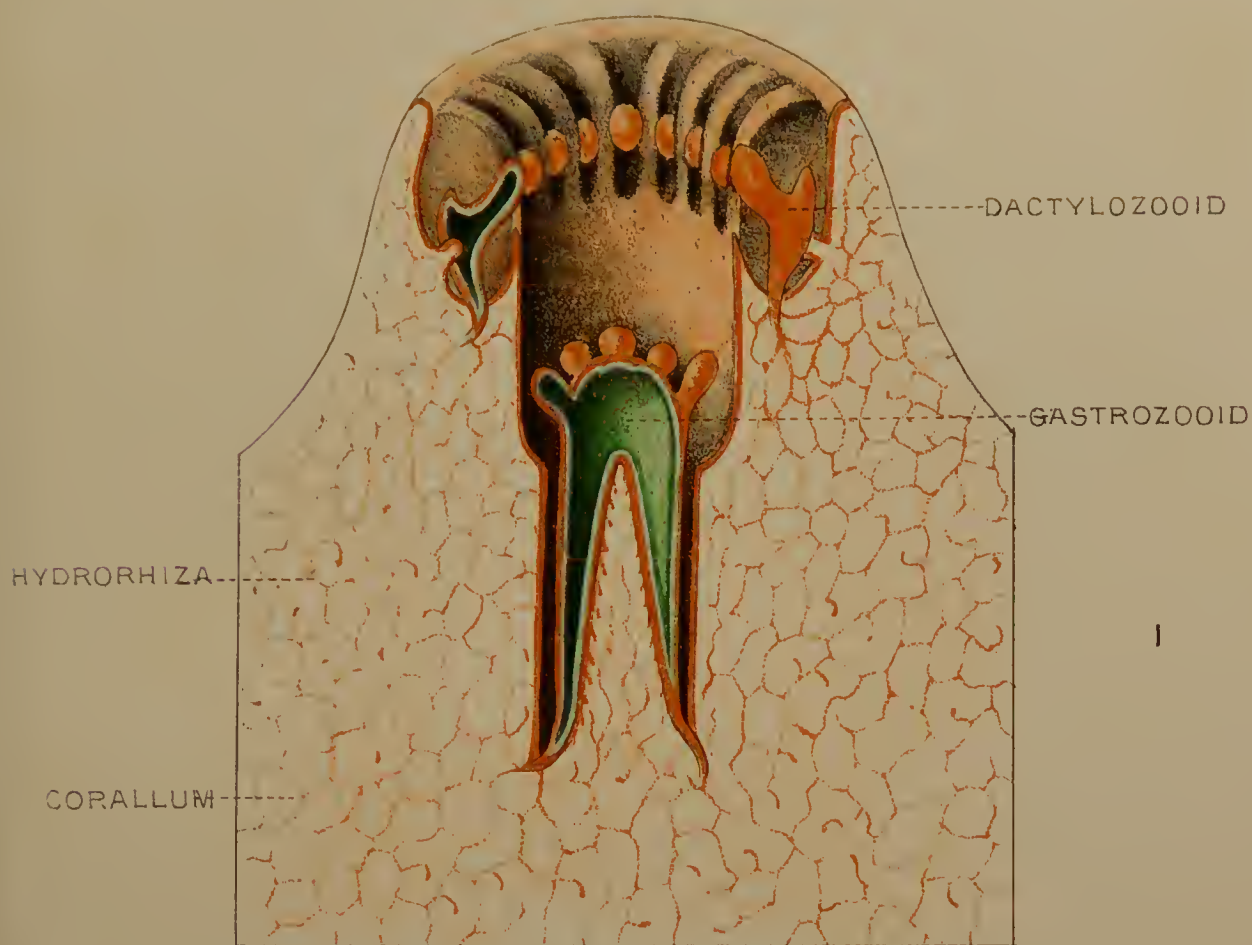
- A. 21.** A simple, free, aporous Coral (*Fungia actiniformis*), with diagram. It results from the detachment of the enlarged free end of a fixed coral resembling the preceding specimen. The septa are united by calcareous bars (synapticulæ), which contribute to the strength of the coral. Pl. II. fig. 1.

Bourne, Q. J. Micr. Sci., vol. xxvii. 1887, p. 293.

- A. 22.** A compound aporous Coral (*Pocillopora cespitosa*), with diagram. The corallum is composed of tubes whose sides are in contact. The cup-like end of each tube lodges a polyp, the bottom of the cup is formed by a plate (tabula). The tabulæ are formed whenever the cup becomes too deep from additions to its lip. The digestive cavities (coelentera) of the polyps communicate with one another by canals (coelenteric canals). Pl. II. fig. 2.

- A. 23.** A fossil Coral (*Favosites gothlandica*). The tabulæ are very distinct. *Brit. Mus.*

- A. 24.** Blue Coral (*Heliopora cærulea*, Order Alcyonaria), and diagram illustrating its structure. The corallum consists of tubules of two sizes. In the larger are lodged the polyps, each having eight pinnate tentacles; the smaller lodge tubular extensions of the digestive cavity of the polyp



C. Stewart del.

1. STYLASTER ROSEUS.

Diagram of Corallum with group of Zooids, Long. sect X 50.

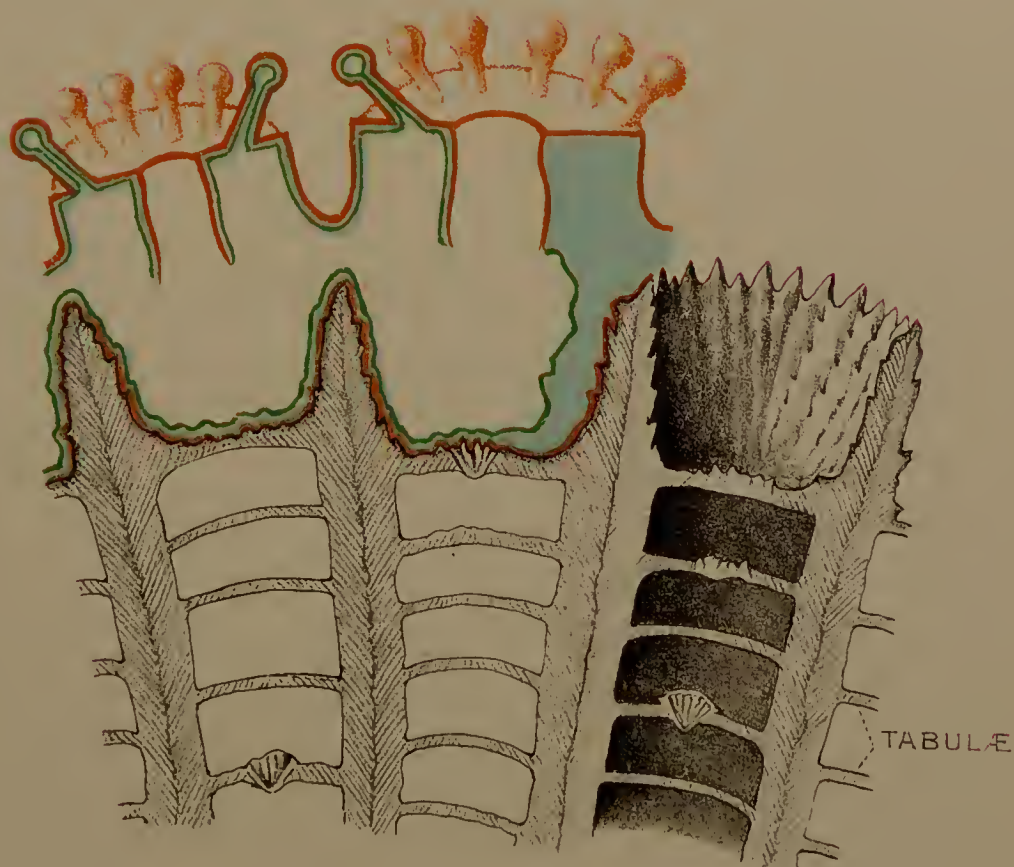
2. CARYOPHYLLIA PROFUNDA.

Diagram of Corallum and Polyp. enlarged.



1

2



C Stewart del.

1. FUNGIA ACTINIFORMIS.

Diagram of vert. sect.

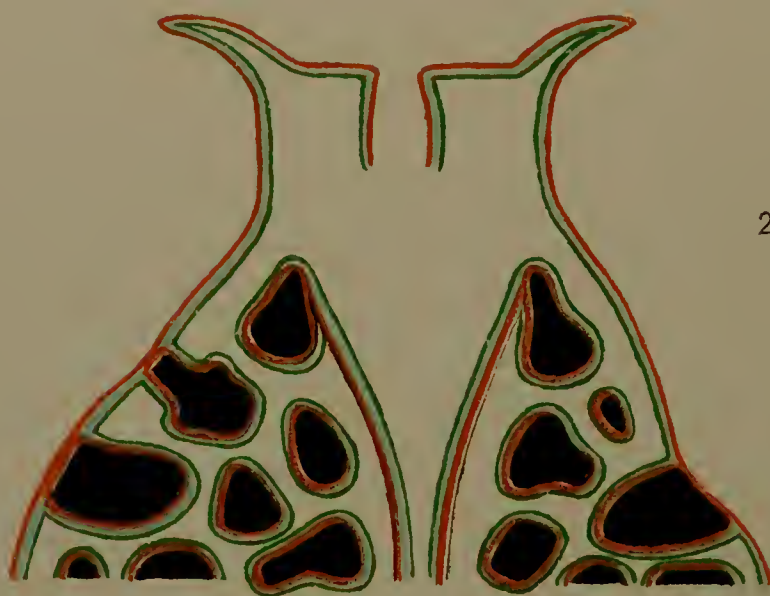
2. POCILLOPORA CESPITOSA.

Diagram of vert. sect. enlarged.





1



2

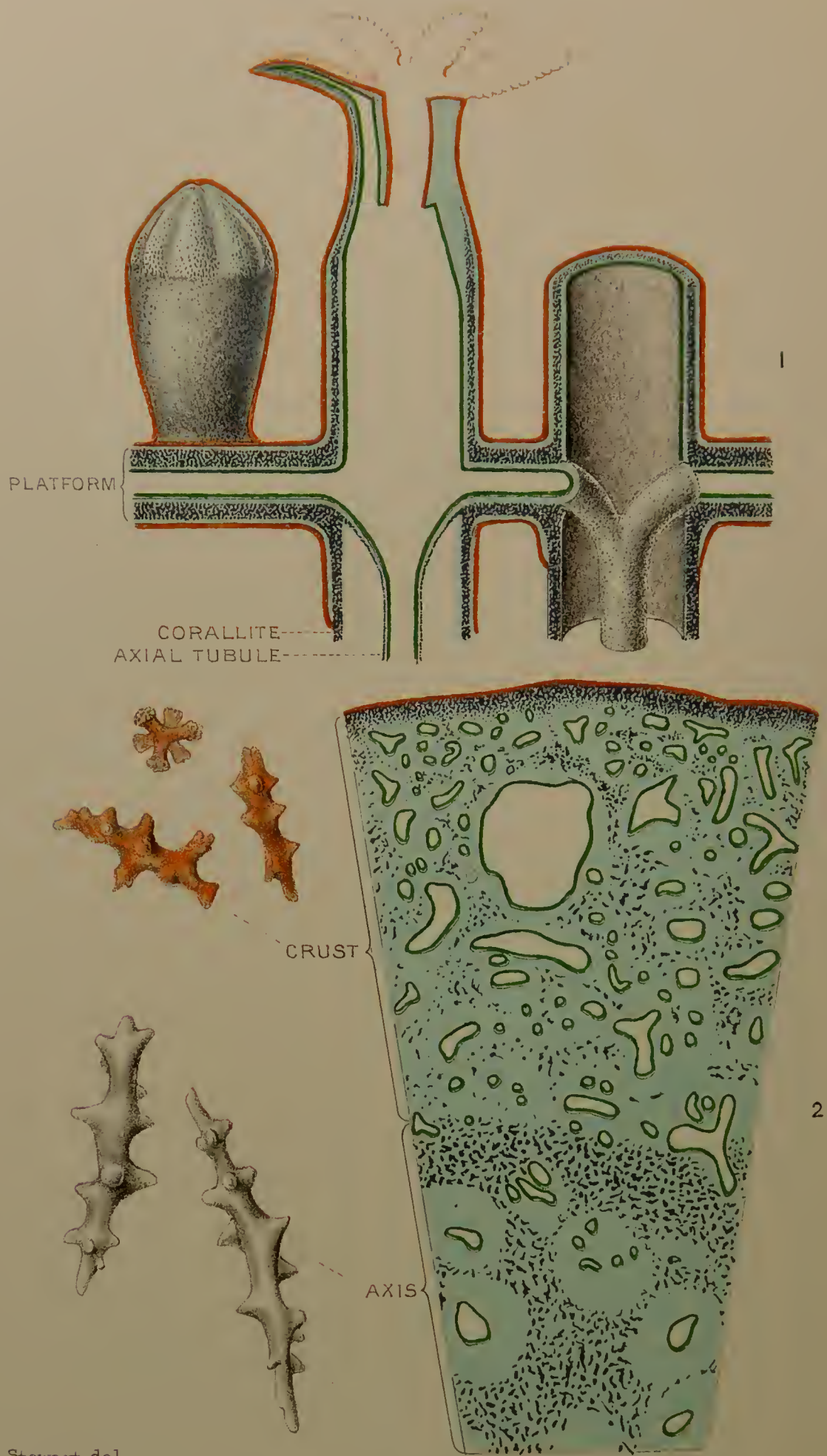
C. Stewart del.

1. HELIOPORA CÆRULEA.

Diagram of vert. sect. enlarged.

2. MADREPORA MURICATA.

Diagram of vert. sect. enlarged.



C. Stewart del.

1. TUBIPORA MUSICA.
Diagram of vert. sect. enlarged.
2. PARAGORGIA ARBOREA.
Trans. sect. $\times 20$, Spicules $\times 150$.

(coelenteric canals). The surface of the organism is alone living, the lower deserted portion of the tubes being cut off by tabulæ. Pl. III. fig. 1.

Presented by Dr. H. Woodward.

Moseley, Phil. Trans., vol. clxvi. 1877, p. 91.

- A. 25.** Perforate corallum of a Madrepore (*Madrepora muricata*). The corallum is permeated by a network of coelenteric canals, so that all except the oldest portions may be regarded as living. The ectodermic cells (calyco blasts) in contact with the external surface of the corallum effect its increase, but they more or less disappear from the deeper parts. Pl. III. fig. 2.

Fowler, Q. J. Micr. Sci., vol. xxvii. 1887, p. 1.

Ogilvie, Phil. Trans., vol. clxxxvii. 1896, p. 83.

- A. 26.** Horny corallum of Black Coral (*Antipathes ulex*). This material is tougher and less rigid than that of the preceding specimens.

Skeleton consisting in part or entirely of separate sclerites (spicules).

Each spicule is formed in an ectodermic cell that has migrated into the mesoglæa (firm jelly-like substance between ectoderm and endoderm, formed by the ectoderm).

- A. 27.** *Spongodes florida*, a colonial Alcyonarian. Some of the supporting spicules are shown, detached, by the side of a drawing of their microscopic appearance.

- A. 28.** Two specimens, and diagram of the structure of an Organ-pipe Coral (*Tubipora musica*, Order Alcyonaria). The tubes and platforms that unite them are formed by fused spicules, the spicules in the polyp-walls remaining separate. Coelenteric canals running in the platforms unite the polyps. A small inner tube is often formed as the result of the detachment and shrinkage of the soft tissues that line the outer large tube. Pl. IV. fig. 1. *Presented by Prof. C. Stewart.*

Hickson, Q. J. Micros. Sci., vol. xxiii. 1883, p. 558.

The following specimens illustrate the modifications of the central supporting axis in the Gorgonacea (Axifera of Gray). The crust outside the axis always contains numerous spicules.

Kölliker, *Icones Histologicæ*, Zweite Abtheilung, 1865.

G. v. Koch, *Morph. Jahrb.*, Bd. iv. 1878, p. 447.

Axis containing cœlenteric canals.

- A. 29. Small piece of *Paragorgia arborea*, and two transverse sections. The axis is not well defined; it consists mainly of firm mesoglœa with some spicules, and is traversed by cœlenteric canals. The spicules are most abundant near the surface of the axis, and in the mid spaces between the canals. The extended polyps may be seen on the surface of the specimen. The entire colony is branched mostly on one plane, and is often 1·5 or 1·8 metres in height, with diameter at base of 15 to 20 cm. *Presented by Prof. C. Stewart.*

- A. 30. Portions of *Paragorgia arborea*, with diagram and drawings of its structure. Pl. IV. fig. 2.

Presented by Prof. C. Stewart.

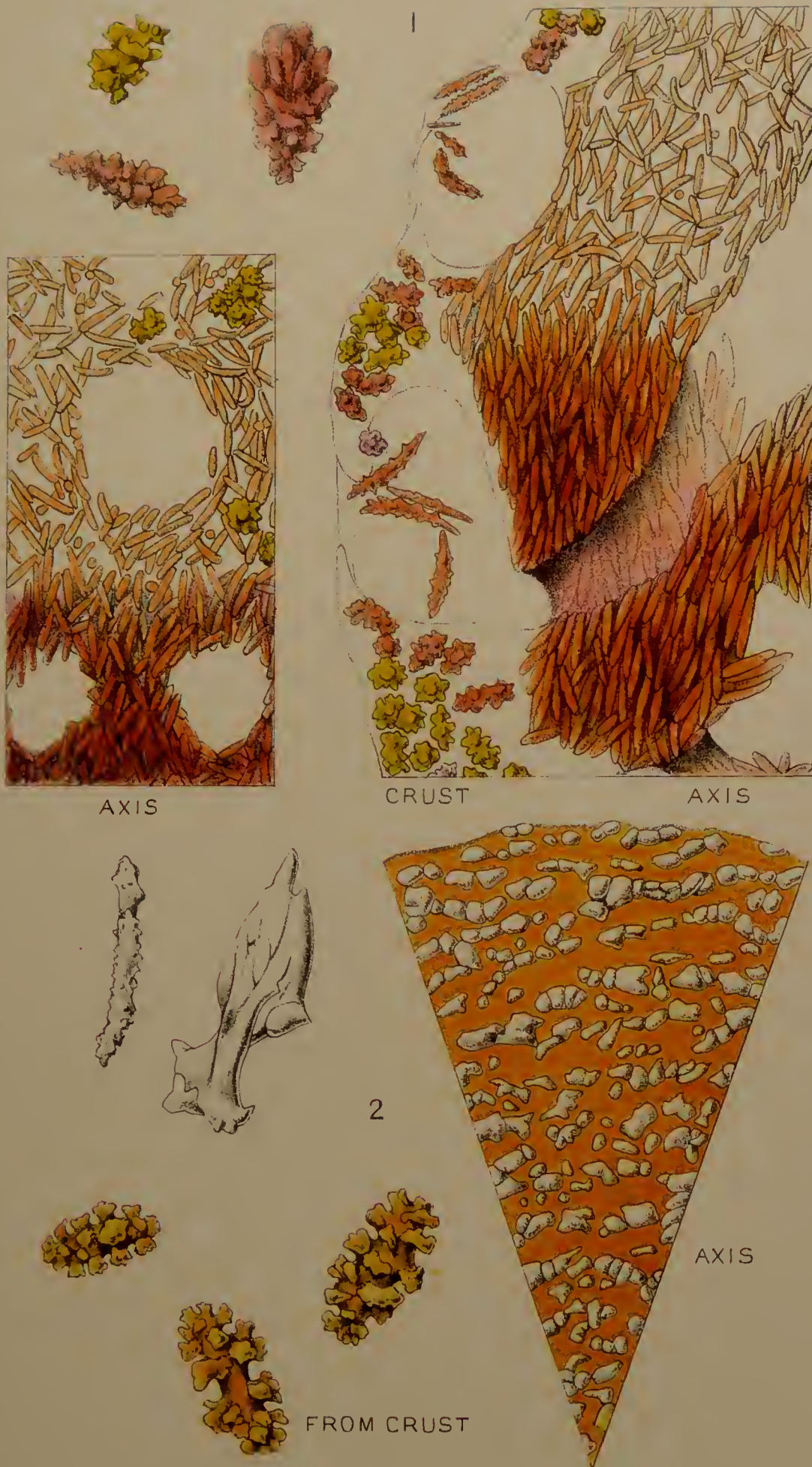
Axis formed by fused spicules and containing cœlenteric canals.

- A. 31. Portions of *Melitodes ochracea*, and drawings of its structure. The axis is jointed, consisting of short thickened nodes composed of loosely arranged spicules united to one another by their extremities; the internodes are of a darker colour, containing more inorganic matter and with densely crowded and fused spicules. The spicules of the axis differ in form from those of the crust, but amongst them are occasionally found some of the crust-spicules that have been extruded from that structure. The axis is traversed by cœlenteric canals. Pl. V. fig. 1.

Presented by Prof. C. Stewart.

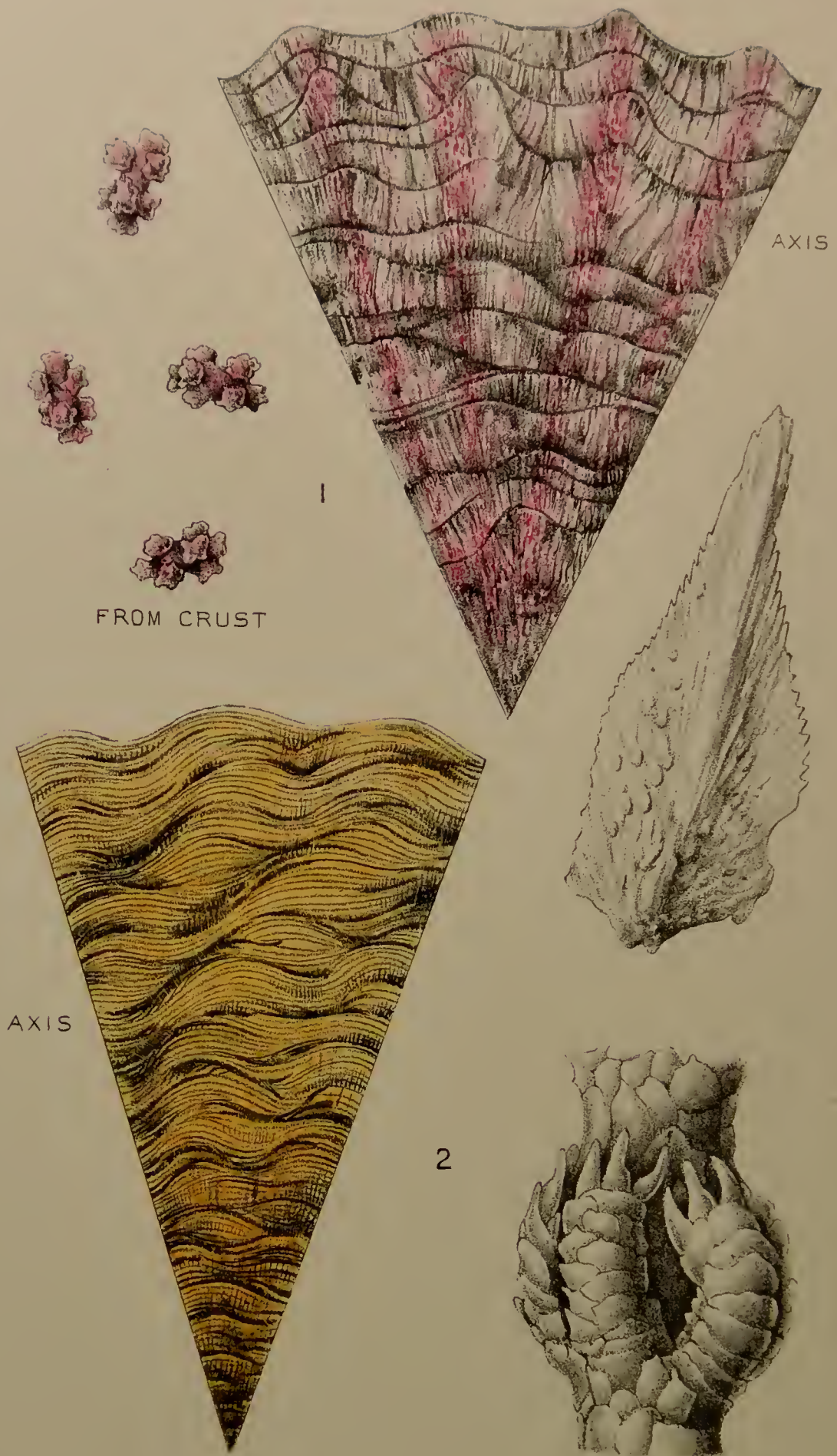
Axis solid, and secreted by a layer of special ectodermic cells (calycolasts).

- A. 32. *Suberogorgia suberosa*, with drawings of its structure. The axis is composed of colourless spicules and horny



C Stewart del.

1. MELITODES OCHRACEA.
Trans. and long. sects $\times 80$ *Spicules* $\times 150$.
 2. SUBEROGORGIA SUBEROSA.
Trans sect. $\times 80$ *Spicules* $\times 150$.



C. Stewart del.

1. CORALLIUM RUBRUM.

Trans. sect. $\times 160$. Spicules $\times 150$.

2. CALIGORGIA VERTICILLATA.

Trans. sect. $\times 100$. Group of Polyps on stem $\times 25$. Spicule $\times 150$.



C. Stewart del.

1. VERRUCELLA GUADALUPENSIS.

Trans. sect. $\times 100$. Spicules $\times 150$.

2. ISIS HIPPURIS.

Trans. sect. of calc. internode $\times 50$. Spicules $\times 150$.

matter disposed in ill-defined layers. The spicules differ from those of the crust, and are mostly fused in groups of two. Pl. V. fig. 2.

- A. 33. Red Coral (*Corallium rubrum*). One piece is still invested by the crust, from the other the crust has been removed to show the axis, grooved on its surface for the coelenteric canals of the crust. A drawing shows the structure of the axis, which is composed of layers of mixed calcium carbonate and organic matter; in it are imbedded numerous spicules derived from the crust. Pl. VI. fig. 1.

Lacaze-Duthiers, Hist. Nat. du Corail, 1864, p. 102.

- A. 34. *Caligorgia verticillata*, with drawings of its structure. The axis consists of an intimate mixture of calcium carbonate and horny matter, disposed in well-defined wavy layers. Pl. VI. fig. 2.

- A. 35. *Verrucella guadalupensis*, with drawing of its structure. The axis closely resembles that of A. 34, but its layers are mostly parallel; occasionally spicules extruded from the crust have modified the arrangement of the layers. Pl. VII. fig. 1.

- A. 36. Various portions of *Isis hippuris*, some in section, with drawing of its structure. The axis is jointed, consisting at first of short horny nodes alternating with long calcareous internodes. As the axis increases in thickness the horny matter is formed in excess of the calcareous, and may in places overlap and conceal it. In the oldest parts of the axis this sometimes is followed by an increased formation of the calcareous material forming a continuous layer on the surface. The ridges on the surface of the internodes are continued inwards on the surface by which they are attached to the nodes. The ectoderm-cells that secrete the calcareous internodes are large and granular, with indistinct nucleus. Those that secrete the horny nodes are about half the size of the former, clear, and with a distinct nucleus. Pl. VII. fig. 2.

G. v. Koch, Morph. Jahrb., Bd. iv. 1878, p. 116.

- A. 37. *Plexaurella crassa*, with drawing of the structure of the axis and crust-spicules. The solid axis consists of horny

material and wedge-shaped bars of calcareous matter in nearly equal proportion. The calcareous bars show on section a finely laminate structure with radial striation. Pl. VIII. fig. 1.

- A. 38. *Eunicella verrucosa*, and diagram of its structure. The axis is composed of horny matter disposed in layers. At the growing tips of the branches the central first-formed portion is spongy and contains much water. This form of axis being elastic and strong is probably best fitted to resist injury, and is the type most prevalent amongst Gorgonacea. Pl. VIII. fig. 2. *Presented by Prof. C. Stewart.*
G. v. Koch, Morph. Jahrb., Bd. iv. 1878, p. 269.
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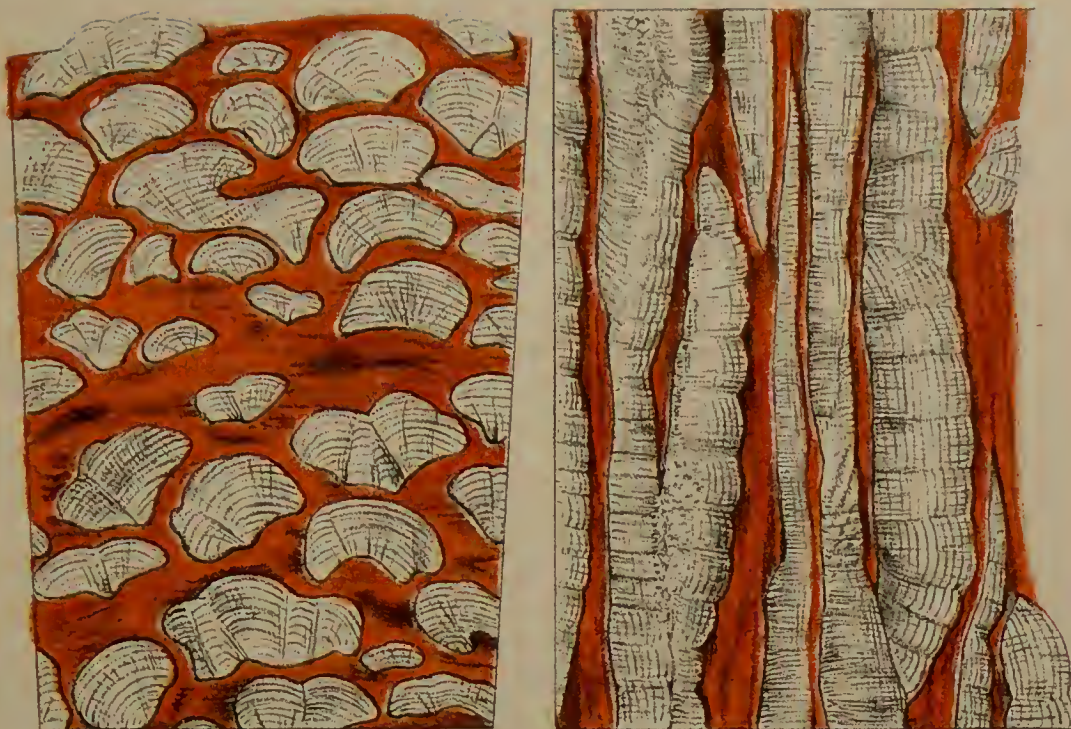
ALCYONARIA that live with the lower end of the stem imbedded in mud or fine sand.

Kölliker, Anat. Syst. Beschr. d. Alcyonarien, i. Pennatuliden, 1872.

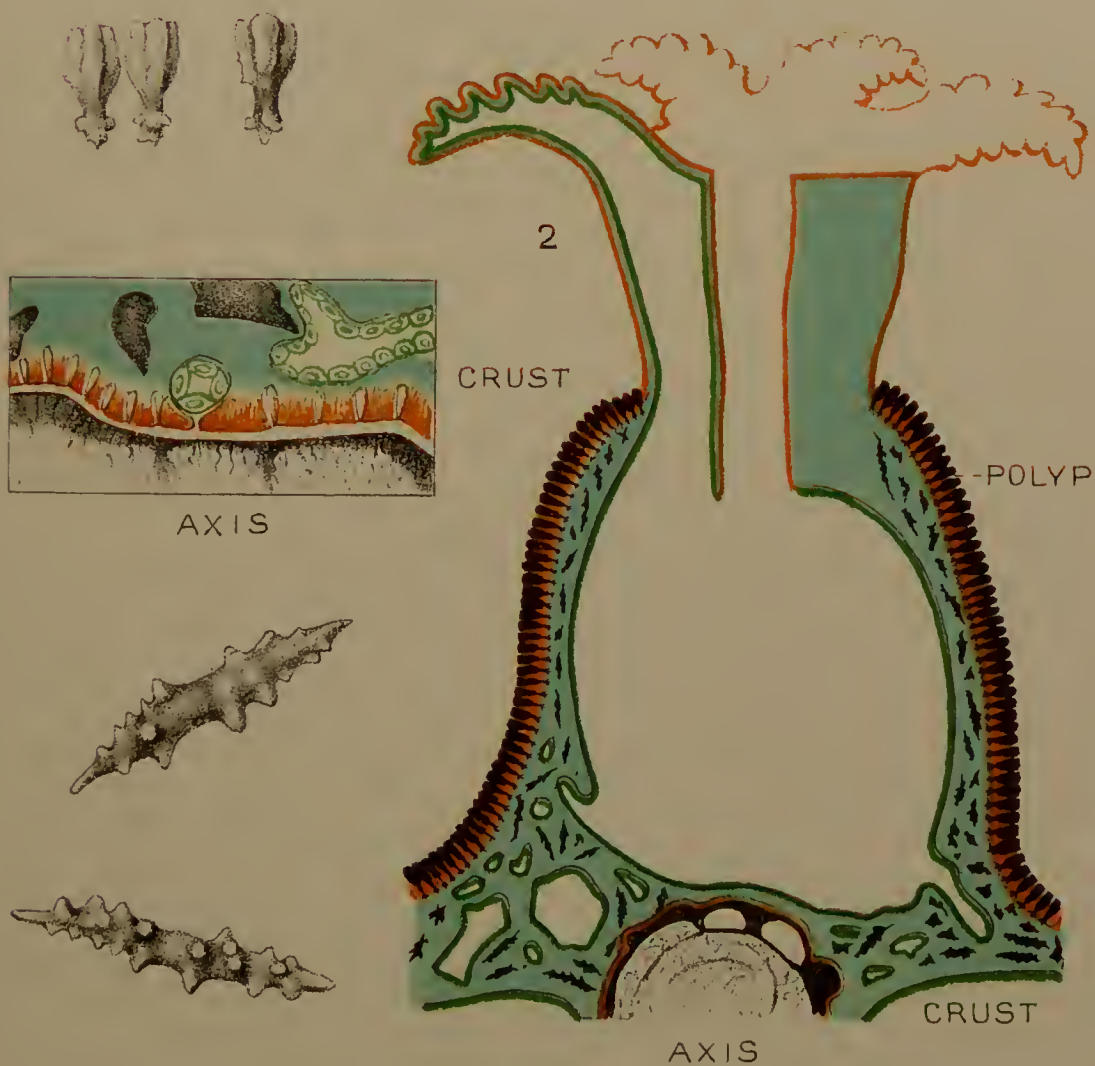
- A. 39. A Sea-pen (*Pennatula phosphorea*), laid open to expose the slender cylindrical axis, which consists of an intimate mixture of calcium carbonate and organic matter. O. C. 88. *Hunterian.*
- A. 40. A Sea-pen (*Pennatula grisea*), laid open along the anterior aspect to expose the central axis. Large needle-shaped spicules are abundant in the pinnules. O. C. 227. *Hunterian.*
- A. 41. A longitudinal section of *Pennatula grisea*, exhibiting the structure of the central stem. O. C. 228. *Hunterian.*

ECHINODERMATA.

- A. 42. A Feather-star (*Antedon rosacea*). The endoskeleton is composed of a great number of small pieces formed in the connective tissue. They consist of a minute network of combined calcium carbonate and organic matter. The network usually first appears in the substance of intercommunicating cell-processes. The connective tissue of



AXIS



C. Stewart del.

1. PLEXAURELLA CRASSA.
 Trans and long. sects. $\times 100$.
 2. EUNICELLA VERRUCOSA.
 Diagram of Polyp and axis $\times 40$
 Sect. of axis and crust $\times 400$. Spicules $\times 100$.

the visceral disc is stiffened by minute disc-shaped spicules often perforated in the centre.

Presented by Prof. C. Stewart.

- A. 43.** Two half-grown specimens of a Sun-star (*Solaster papposus*). The viscera and upper (abactinal) body-walls have been removed from the lower specimen. The ambulacral plates including those of the oral system, the plates in the interradial septa (interbrachial pillars), and the stone-canal constitute the endoskeleton. From the upper specimen have been removed the whole of the body-walls excepting the adambulacral plates. *Presented by Prof. C. Stewart.*

- A. 44.** A Snake-armed Starfish (*Ophiocoma erinaceus*). The viscera and upper (abactinal) wall of the disc have been removed to show the ossicles about the mouth, and the vertebral ossicles (=fused ambulacral plates) that are continued from the arms into the disc. One arm has been detached with the six vertebral ossicles that were included in the disc. Some of the vertebral ossicles of the arm have been exposed by removing four of the dorsal (abactinal) shields. Three vertebral ossicles are shown in different positions, and below are enlarged models of these having on one side the surfaces giving attachment to the intervertebral muscles, painted red. A blue rod has been passed on one side into the opening by which the lateral branch of the radial water-vessel enters the ossicle, in the substance of which it forms a loop, and emerges in a cup-like depression to which the tube-foot is attached. The vertebral ossicles and oral skeleton form the endoskeleton.

Presented by Prof. C. Stewart.

Ludwig, Zeitschr. wiss. Zool., Bd. xxxi. 1878, p. 347.

- A. 45.** *Echinometra lucunter*. The shell (corona) has been cut in half, and the spines removed. The lower half shows five arch-like processes (auricula) that project into the interior and give attachment to certain of the jaw-muscles. The upper half shows the five genital organs (gonads); these, together with the intestine, mesentery, and other organs, are stiffened by numerous characteristic spicules that, like

those of calcareous sponges, are optically as if carved from a crystal of calcite, but their forms are organic and often closely resemble siliceous spicules.

Stewart, Trans. Linn. Soc., vol. xxv. 1866, p. 365.

- A. 46.** Two halves of a Cake-urchin (*Clypeaster humilis*). Processes of the test arise from the under (actinal) and upper (abactinal) body-walls, the former being twice the length of the latter; they meet and firmly articulate without fusion. They must greatly increase the strength of the test. There are also fine needle-like processes where the intestine is lodged, and five pairs of processes around the mouth (peristomal interambulacral apophyses).

Presented by Prof. C. Stewart.

- A. 46 a.** Test of a Cake-urchin (*Clypeaster rotundus*), the upper (abactinal) portion being removed, and the jaws (pyramids) left *in situ*. The strengthening wall-like columns are confined to the margin of the test. They are grouped into five interradial sets. In each set the walls bound a central area that opens towards the vertical axis of the body, and has processes extending towards its interior. From the outer sides of the wall bounding the central area extend more strongly developed walls mostly parallel to the margin of the test; these are separated from similar walls of neighbouring sets by about 3 mm. In this form the connecting pillars and processes, the five processes (peristomal interambulacral apophyses) around the mouth, and the five jaws (pyramids) constitute the endoskeleton.

- A. 47.** A Sea-cucumber (*Holothuria nigra*), laid open. The mouth is surrounded by a ring of ten calcareous plates, five radial to which the longitudinal muscles of the body are attached, and five interradial.

Presented by Prof. C. Stewart.

ANNELIDA.

- A. 48.** A tube-dwelling worm (*Spirographis spallanzanii*), showing the branchial skeleton of the right side. The main portion of the skeleton consists of two tapering ribbons of

cartilage, each forming an elongated spiral; they are joined to one another on the dorsal region of the worm by a narrow bridge. Long slender rods arising from the anterior edge of each scroll pass up the centre of the branchial filaments, and from these rods smaller skeletal cores enter the individual pinnules. The skeleton is composed of a variety of cartilage, consisting of large vacuolated cells whose walls are formed by a small amount of firm substance.

Viallanes, Ann. Sci. Nat., ser. 6, t. xx. 1885, p. 1.

BRACHIOPODA.

- A. 49. The dorsal and ventral valves of a Brachiopod (*Magellania septigera*). The shell consists of organic matter hardened by calcium carbonate and a considerable proportion of calcium phosphate. A complicated process (loop) springs from the dorsal valve close to the hinge; it gives support to the "arms," and functions as an endoskeleton.

CRUSTACEA.

- A. 50. Endophragmal system of a Lobster (*Homarus vulgaris*). Infoldings (endopleurites) of the calcified cuticle project inwards from the sides of the body in the intervals between the segments. Each has a backward-directed process that divides the area corresponding with the limb into an internal region lodging the protractor muscle, and an external for the retractor. One of the endopleurites has been painted light blue on its posterior face, the succeeding endopleurite dark blue on its anterior. Between the ventral plates (sterna) arise similar vertically directed bifid processes (endosternites), painted red; they articulate with the endopleurites, and with one another in the mid line. The two articular surfaces for the limb are painted black. The sterna and their processes form a canal for the protection of the ventral nerve-cord and artery, and, with the endopleurites, give attachment to muscles.
- A. 51. Ventral portion of the antepenultimate segment of the cephalothorax of a Lobster (*H. vulgaris*). The endopleurites and endosternites have each been divided—

their posterior halves being left in front of the segment, their anterior behind. On the left side the anterior half of the endopleurite is painted light blue, the posterior dark. The endosternites are similarly treated with red.

- A. 52.** Entosternite of *Apus productus*. It is attached by muscles to the cuticle of the body-walls, and lies between the nervous system below and alimentary canal above. It has the structure of fibro-cartilage. The entosternite is thought to be represented in the Lobster by a small thin plate of connective tissue that lies immediately above the expanded inner ends of the first pair of endosternites.

Presented by H. M. Bernard, Esq.

Ray Lankester, Q. J. Micr. Sci., vol. xxiv. 1884, p. 131.

- A. 53.** Entosternite of King Crab (*Limulus polyphemus*). It has the same general structure and position as the former specimen. In chemical composition it consists of a chondrin-like body, and chitin (1.01 %).

Presented by M. F. Woodward, Esq.

Halliburton, Q. J. Micr. Sci., vol. xxv. 1885, p. 179.

ARACHNIDA.

- A. 54.** Entosternite of a Scorpion (*Palamnæus spinifer*). It has the usual minute structure and composition of that of other Arthropods. It consists of a stoutish body situated in the thorax between the alimentary canal and the nervous system, and of two "posterior flaps" or wings that extend upwards and backwards, having the position of a diaphragm situated at the junction of the cephalothorax and abdomen.

Schinkewitsch, Zool. Jahrb., Bd. viii. 1895, p. 191.

- A. 55.** Entosternite, together with the ventral plate (sternum) and proximal portions of the limbs of a Spider (*Theraphosa blondii*). The entosternite was loosely attached to the sternum by three pairs of slender processes. It gave attachment to numerous muscles.

- A. 56. Portion of a Spider (*Theraphosa blondii*), the carapace and soft parts have been removed to show the entosternite *in situ*.

INSECTA.

- A. 57. A section of the Hercules Beetle (*Dynastes hercules*), showing three dorsal and three ventral in-processes of the cuticle that give attachments to muscles. Of the dorsal processes the most anterior = prothorax, springs from the anterior border of the mesothorax; from the posterior border arises the larger mesothorax, the still larger metathorax from the posterior border of the metathorax. These give attachment to the wing-muscles. Ventrally are the antifurca, medifurca, and postfurca that serve for the attachment of the muscles that move the legs. O. C. 224.

Hunterian.

Kirby and Spence, *Introd. to Entomology*, iii. p. 581.

PELECYPODA.

- A. a 58. Valves of *Cucullæa concamerata*. A process of the shell projects inwards, forwards, and downwards in the posterior region of either valve to give attachment to the posterior adductor. In the right valve the area of muscle attachment is painted red.
- A. b 58. The valves of *Pholas* [*Dactylina*] *dactylus*. From the inner surface of the shell near the umbo there is a long slender process (falciform process) to the apex of which the anterior retractor pedis is attached.

GASTROPODA.

- A. 58. The two pairs of buccal fibro-cartilages of an Ormer = Ear-shell (*Haliotis tuberculata*). In the upper specimen they are shown detached; in the lower *in situ* from the left side. These cartilages lie beneath the floor of the mouth, giving support to the tooth-bearing lingual ribbon (radula), and attachments to the muscles that move it.

Wegmann, *Arch. de Zool. Exp.*, t. ii. 1884, p. 297.

CEPHALOPODA.

- A. 59.** The separate cartilages of a Cuttlefish (*Sepia filliouxi*). The equatorial cartilage is peculiar in consisting of large cylindrical cells, mostly arranged in a single layer, and without processes; its matrix is small in quantity and forms a definite layer around each cell. In the other cartilages the cells are small and more or less connected by branched processes; the matrix is very abundant and structureless. It contains 1.22 % of chitin.

Boll, Arch. f. Mikr. Anat., Bd. v. supplement, 1869, p. 14.

Halliburton, Q. J. Micr. Sci., vol. xxv. 1885, p. 174.

- A. 59 a.** A Cuttlefish (*Sepia filliouxi*) in which the natural position of the cartilages is shown by the entire removal of the soft parts on the left side.

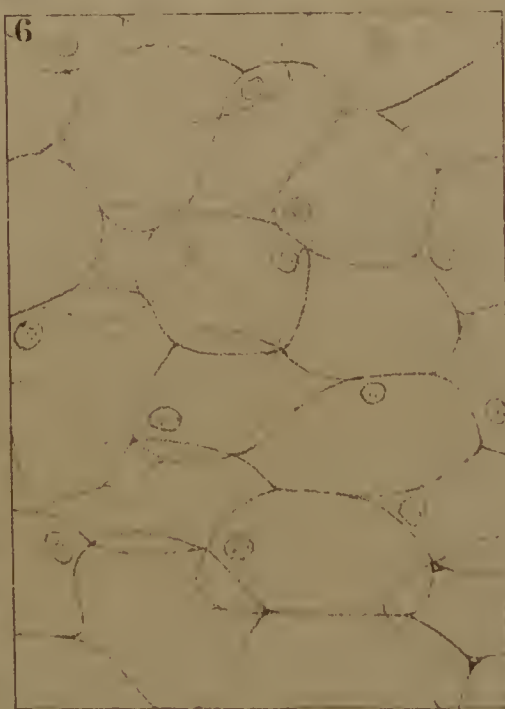
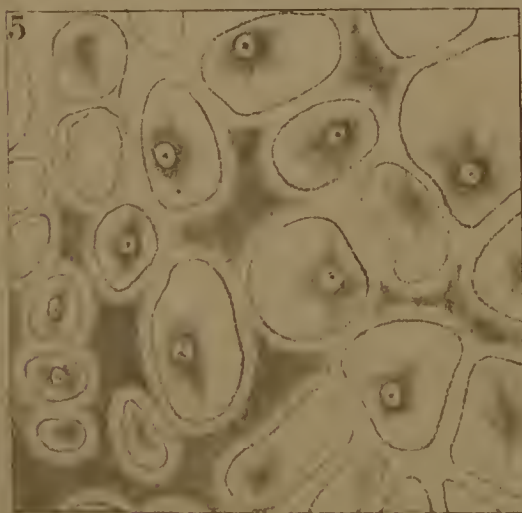
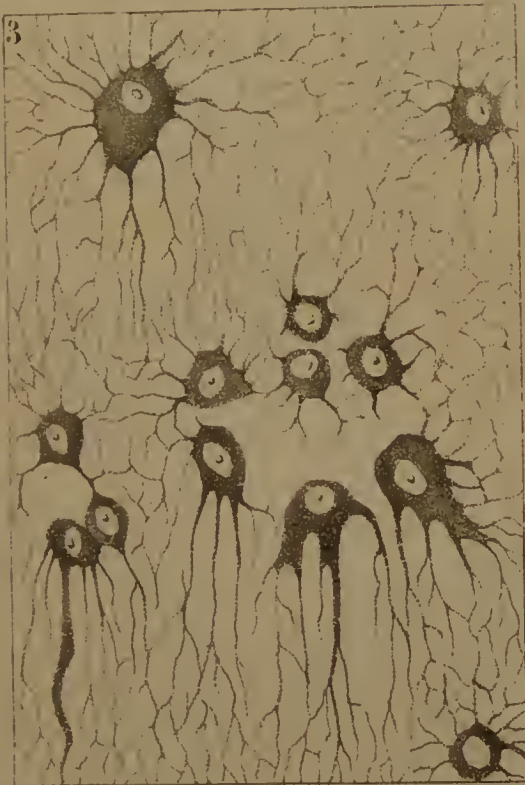
- A. 59 b.** A transverse section of the gill of a Cuttlefish (*Sepia officinalis*), comprising four gill-lamellæ. The lamellæ have been removed on the right to show a delicate rod of cartilage that stiffens the free border of the supporting membrane of each.

- A. 59 c.** The cartilaginous skeleton of *Nautilus pompilius*. When in its natural position the cartilage lies close behind the buccal mass, sloping from above downwards and forwards. The upper horns with their processes support the central nervous system, the ventral flattened processes are embedded in the sides, and the median in the roof, of the funnel. In structure the cartilage corresponds to that of *Sepia*.

CEPHALOCHORDA.

- A. 60.** The endoskeleton of *Amphioxus lanceolatus*. The skeleton comprises a notochord, buccal cartilages, and a dorsal and ventral row of fin-supports.

The notochord extends from *in front* of the central nervous system to the tip of the tail, and consists of a soft core surrounded by a double sheath. The core is composed of a series of transversely striated plates (possibly the walls of extremely flattened chordal cells) arranged at right



Stewart del

CARTILAGE X300.

1. SPIROGRAPHIS. *branchial*
3. SEPIA (*gold prep.*) *cephalic*
5. PETROMYZON. *cranial*

2. HALIOTIS. *buccal*
4. SEPIA. *equatorial*
6. PETROMYZON. *notochord*

angles to its longitudinal axis : they are attached laterally to the internal notochordal sheath, but are separated from it, above and below, by a mass of branching cells (Müller's tissue). The sheath consists of a thin elastica interna and a thicker outer fibrous layer.

The buccal cartilages, situated along the ventral and lateral margins of the oral hood, are formed by the union of a series of short segments. A process from the dorsal end of each segment forms the cartilaginous support of a cirrus. These cartilages have essentially the same structure as the notochord.

The supports of the dorsal and ventral fins are composed of a soft structureless material traversed by a few fine fibres. Each support is contained within an oblong lymph-space.

Chorda. v. Ebner, SB. Ak. Wien, Bd. civ. 1895, p. 199.

Buccal cartilages. Rolf, Morph. Jahrb., Bd. ii. 1876, p. 101.

Fin-supports. Pouchet, Q. J. Micr. Sci., vol. xx. 1880, p. 426.

FISHES = PISCES.

Chemical composition.

“ Bone is a compound of animal substance and calcareous earth, and serves to support the other parts of the machine, so as to allow of the different parts being kept at a certain distance from each other, and to be acted upon by the muscles or moving powers of the body.

“ These (the Bones) are of different shapes in almost every class of animals, varying as it is necessary for defence from external accidents, strength, velocity, or convenient attachment of muscles.

“ In some they are similar to shell, serving as a house for the animal, as in the turtle ; and in the more perfect animals they serve the same purpose for particular parts.

“ In quadrupeds, in some they are very cellular, thin, and spongy ; in others, very hard, solid, and compact, according as strength is required.”—*Hunterian MS. Catalogue.*

- A. 61. The vomer of a Cod-fish (*Gadus morrhua*), which has been steeped in an acid, in order to remove the calcareous

earth, and show the proportion of animal substance, which in this species is very considerable. O. C. 112. *Hunterian*.

A. 62. Bone of the pectoral fin of a Cod-fish (*Gadus morrhua*), similarly treated. O. C. 115. *Hunterian*.

A. 63. Some bones of a fish (*Belone?*) from the South Seas, showing a green colour. O. C. 219 c. *Hunterian*.

A. 63 a. Various bones of a Gar-fish (*Belone vulgaris*). The matrix of the bone is of a green colour due to Vivianite (ferrous phosphate).

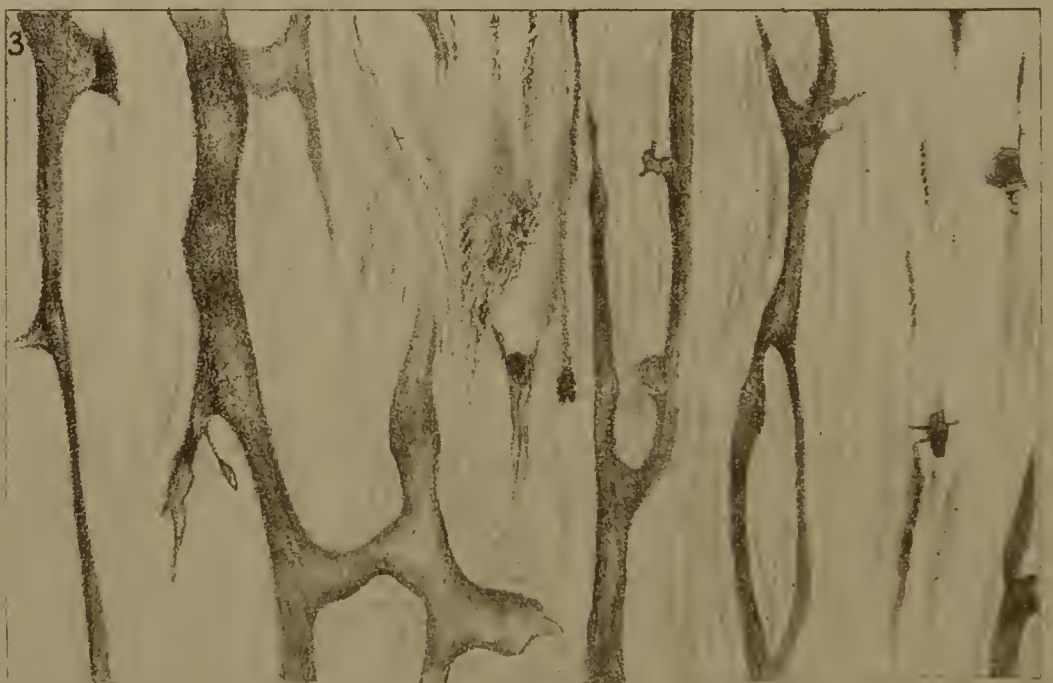
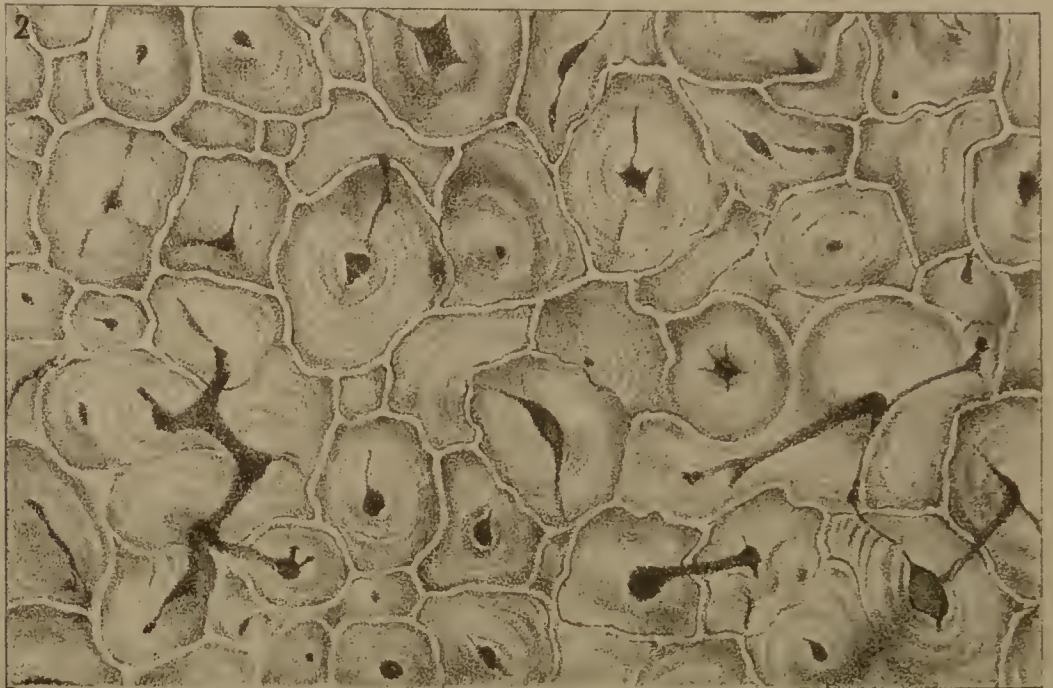
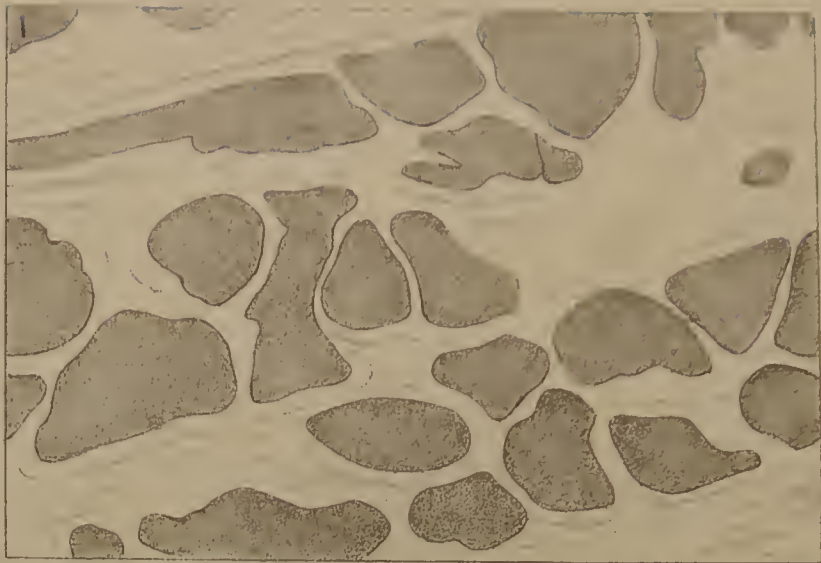
A. 63 b. Diagrams showing the proportion of the constituents of a Haddock's bone (*Gadus aeglefinus*). It will be seen that nearly 50 % of fresh bone is water, that calc. phosphate is nearly the sole inorganic constituent, and that about 18.5 % is organic. The analysis was made by A. Gordon Salamon, Esq.

Structure.

A. 64. Cartilaginous skeleton of a freshwater Lamprey (*Petromyzon fluviatilis*). The axial rod (notochord), that extends nearly the whole length of the animal, consists of large vacuolated cells polygonal by mutual pressure, the matrix forming an extremely thin separating layer between the cells. In the other cartilages the cells are also polygonal from pressure, but the matrix is more abundant, forming a definite layer around each cell; the combined thickness of the matrix between two cells being about a fourth of the diameter of a cell.

A. 65. Transverse and longitudinal sections of the body of a Sea-Lamprey (*Petromyzon marinus*), showing the relations of the notochord. It is surrounded by a double sheath composed of an inner fibrous layer that can be split into three sheets according to the course of the fibres, and a thin homogeneous outer layer (elastica externa). The sheath is itself enveloped by a considerable quantity of dense skeletogenous tissue.

v. Ebner, Zeitschr. wiss. Zool., Bd. lxii. 1896, p. 469.



C. Stewart del.

BONE.

1. GADUS, $\times 150$. 2. XIPHIAS *trans. sect.* $\times 200$
3. XIPHIAS, *long. sect.* $\times 200$.

A. 66. Anterior portion of the body of *Bdellostoma cirrhatum*. The soft parts have been removed from the left side to show the cartilaginous skeleton.

A. 67. Piece of the jaw of a Shark. Near the surface of the cartilage is a layer of plates of calcified cartilage.

Hunterian.

A. 68. Two portions of the layer of plates of calcified cartilage, one showing the deep, the other their superficial surface, from a Shagreen Ray (*Raja fullonica*). The plates are mostly hexagonal, and about 0·8 mm. in diameter. The outer surface of the plates is flat, the deep surface has strong ridges that radiate from the centre, and are in number equal to the sides of the plate and at right angles to them. A thin layer of uncalcified cartilage commonly invests the surface.

Leydig, Beitr. Anat. u. Entwickl. der Rochen u. Haie, 1852, p. 4.

A. 69. Cartilaginous skeleton of a young Ray (*Raja maculata*).

A. 70. Skeleton of a Sterlet (*Acipenser ruthenus*). It is largely composed of cartilage. The bone contains lacunæ with numerous canaliculi. The cranial bones forming part of the exoskeleton have been removed from the left side.

Klaatsch, Morph. Jahrb., Bd. xvi. 1890, p. 233.

A. 70 a. Skeleton of Bony-Pike (*Lepidosteus osseus*), chiefly composed of bone.

A. 71. Skeleton of a Haddock (*Gadus aeglefinus*), and drawing of the bone structure. The bones of Gadidæ consist of matrix in which are spaces occupied by fluid, and various sized droplets of organic matter that stain readily by reagents. There are no blood-vessels or included cells.

A. 72. Skeleton of a young Sword-fish (*Xiphias gladius*), with drawings of the microscopic structure of the bone. It consists of matrix disposed in concentric layers around the numerous blood-vessel-containing channels (Haversian canals.) There are no included cells, but from a few of

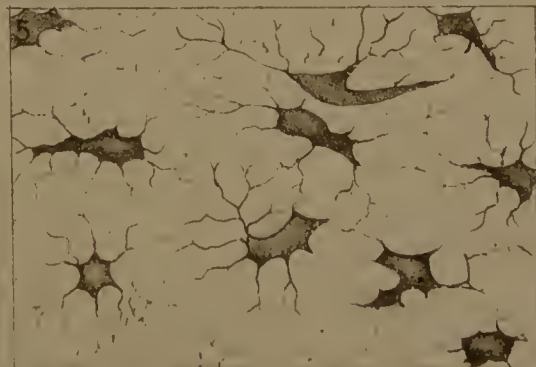
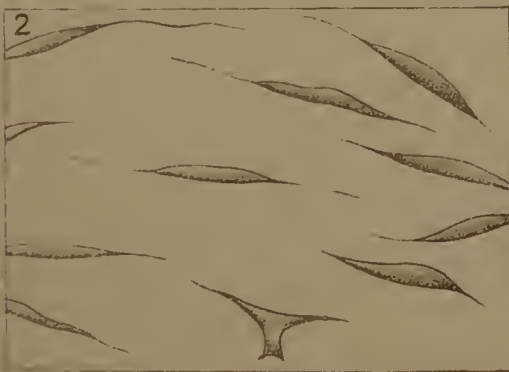
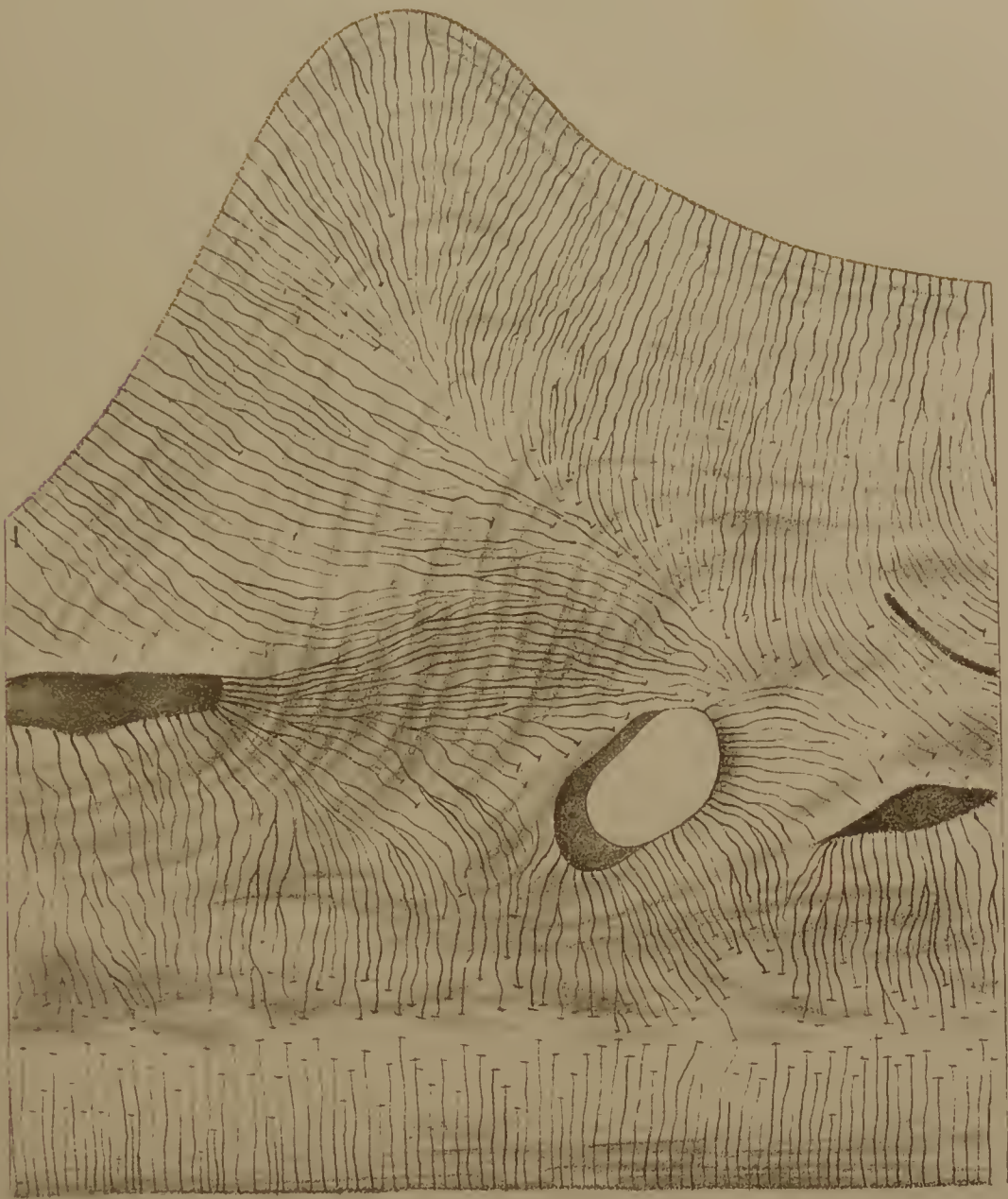
the canals minute tubes, like those of dentine, radiate for a short distance into the matrix. These tubes are most marked in *Histiophorus*.

- A. 73. Skeleton of a young *Pistularia serrata*, and skull of an adult. The bones in this fish, as also in all Pleuronectidæ (Flat-fishes), are traversed by numerous Haversian canals from which and from the surface of the bone numerous dentine-like tubules pass into the matrix. A drawing shows the structure.
- A. 74. Skeleton of Trout (*Salmo fario*) and Grayling (*Thymallus vulgaris*). As in all Salmonidæ, cells lodged in lacunæ are present but are not provided with intercommunicating canaliculi. The structure is shown in a drawing.
- A. 75. Skeleton of Herring (*Clupea harengus*) and Carp (*Cyprinus carpio*). A drawing shows the well-developed lacunæ and canaliculi present in all Clupeidæ and Cyprinidæ.

REPTILES = REPTILIA.

- A. 76. The carapace of a very young Turtle (*Chelone mydas*), showing the state of ossification, which is continued from the margins of the ribs, at this period quite distinct from each other, into a pre-existing ossifiable basis of the costal plates, until these plates become joined by indented sutures similar to those of the cranium. O. C. 131. *Hunterian*.
Goette, Zeitschr. wiss. Zool., Bd. lxvi. 1899, p. 407.
- A. 76 a. Longitudinal section of the left humerus of a Turtle (*Chelone mydas*). There are no epiphyses. The articular cartilage is 4 mm. thick, and has the normal milk-white opacity; the cells are small and arranged in rows irregular in direction. At its deepest part the cells are mostly in rows parallel to the surface. Below this cartilage is a translucent layer 1 mm. thick; the cells in it are rounded, larger than in the former, and arranged in vertical rows. Beneath this is a layer of similar thickness in which calcification of the matrix is taking place. There is much black pigment in the medulla, mostly following the course of the larger blood-vessels. Preserved in 50 % glycerine.

Presented by G. Ring, Esq.



C. Stewart del.

BONE.

1. FISTULARIA *vert. sect.* $\times 100$.

2. SALMO $\times 300$

4. CLUPEA $\times 300$.

3. THYMALLUS $\times 300$.

5. CYPRINUS $\times 300$.

- A. 76 b. Longitudinal section of the left humerus of a Turtle (*Chelone mydas*). There is no medullary cavity, its place being occupied by uniformly dense cancellous tissue.
- A. 76 c. Longitudinal section of the left humerus of a Crocodile (*Crocodylus acutus*). A medullary cavity is present. The cancellous tissue at the ends of the bone is dense and shows some tendency to a vertical disposition.

BIRDS=AVES.

- A. 77. The muscles and bones of the hind limb of a Silk-fowl (*Gallus ferrugineus*, var. *morio*), showing the peculiar dark brown colour of the periosteum. O. C. 2057. *Hunterian*.
- A. 78. The right tarso-metatarsus of the domestic Fowl, longitudinally bisected, to show the results of the following experiment :—

When the animal was young, the bone was perforated near each extremity, and a small leaden shot was introduced into each hole. After a certain period the animal was killed, and the length of the bone was found to have been increased to three inches and ten lines; but the distance between the shots, which has now reached the medullary cavity, was exactly the same as when first introduced. [The original note of the experiment is preserved in the bottle.]

—“ And here I must observe, that a bone does not grow in all its parts, that is, it does not grow by addition of new particles among those already arranged, or in their interstices, but by the addition of parts lengthways or sideways of the bone. This I proved by exposing the bones of young animals, and boring holes in them, which were prevented from being obliterated by fixing pieces of leaden shot in them; these bones were examined a considerable time after, when, although the bones had considerably grown, the holes were exactly at the same distance from each other.”—*John Hunter, MS. Lectures*.

O. C. 189.

Hunterian.

- A. 79. The left tarso-metatarsus of the domestic Fowl, upon which the following experiment was performed :—
- Two small holes were made by cauterization near the extremities of the bone; the length of the bone at that time being

two inches and ten lines, and the distance between the holes one inch and eight lines. After a certain period the animal was killed, and the length of the bone was found to be three inches seven lines, while the space between the apertures was one inch and eleven lines; the increase of the bone beyond the points of cauterization being more than double that of the space included between them. [The original note of the experiment is preserved in the bottle.]

O. C. 188.

Hunterian.

- A. 80. The sternum, sternal ribs, and scapular arch of a young Condor (*Sarcorhamphus gryphus*); the sternum with its well-developed keel is formed by one continuous cartilage. Ossification has commenced in the coracoids and scapulæ. O. C. 133 E.

- A. 81. The sternum of a Black Swan (*Cygnus atratus*) 83 days old. O. C. 133 E b.

- A. 82. The sternum of a Black Swan (*Cygnus atratus*) 153 days old. O. C. 133 E c.

- A. 83. A longitudinal section of the ulna of an Owl. The air-cells are not continued into it, its cavity having been filled with medulla. O. C. 211. *Hunterian.*

- A. 84. A longitudinal section of the femur of an Owl, which has also had no connection with the air-cells, but contains medullary matter, and exhibits the difference between such bones and those which contain air. O. C. 212. *Hunterian.*

- A. 85. A longitudinal section of the lower part and articular end of the tibio-tarsus of a young Ostrich, with the vessels of the periosteum injected. O. C. 119 A.

- A. 86. A section of the upper extremity of the tibio-tarsus of a young Ostrich, showing the more compact cellular structure, containing medullary matter; and the epiphysis. O. C. 218. *Hunterian.*

- A. 87. A section of the lower extremity of the tibio-tarsus of a young Ostrich, showing the compact cancellous structure, and the medullary cavity. O. C. 219. *Hunterian.*

MAMMALS = MAMMALIA.

Chemical composition.

A. 88. A small portion of fossil bone deprived of its earth.
O. C. 120. *Hunterian.*

A. 89. A larger portion of fossil bone, prepared in a similar manner. O. C. 121. *Hunterian.*

A. 90. A portion of fossil bone from an animal belonging to the genus *Bos*, prepared in a similar way. O. C. 122.
Hunterian.

A. 91. The animal part of a portion of a Deer's horn (*Cervus giganteus*), from Ireland, in a fossil state. O. C. 123.

Messrs. Apjohn and Stokes found the animal basis to constitute 48·87 per cent. of the weight of the bones of the *Megaceros*: and the following proportions of the earthy constituents:—

Phosphate of lime and magnesia..	43·45
Carbonate of lime	9·14
Ferric-oxide.....	1·02
Silex.....	1·14

Hunterian.

A. 92. The animal part of some small portions of the cranium of the *Ursus spelæus* or Bear of the Caverns, from Bayreuth in Germany. O. C. 124. *Hunterian.*

Hunter, Phil. Trans., vol. lxxxiv. 1794, p. 415.

A. 93. A section of the tympanic bone of a Whalebone Whale (*Balæna mysticetus*), which has been subjected to the action of an acid, and deprived of its earthy constituent. It exhibits a concentric laminated structure and uniform solidity; the first-formed central part not having undergone any change from the action of the acid, and no part exhibiting a trace of fibres, cancelli, or vessels. O. C. 202.

Hunterian.

A. 94. Another section of the same bone, similarly treated, and exhibiting more distinctly the laminated texture. O. C. 203.

“The bony part of the organ (of hearing) is very hard and

brittle, rendering it even difficult to be cut with a saw, without its chipping into pieces. That part which contains the immediate organ is by much the hardest, and has a very small portion of animal substance in it; for when steeped in an acid, what remains is very soft, almost like a jelly, and laminated. The bone is not only harder in its substance, but there is on the whole more solid bone than in the corresponding parts of quadrupeds, it being thick and massy.”—*John Hunter, On the Structure and Economy of Whales, Phil. Trans.* 1787, lxxvii. p. 432.

Hunterian.

- A. 95. A section of the tympanic bone of a Whalebone Whale (*Balæna mysticetus*), similarly treated. O. C. 116.

Hunterian.

- A. 96. A portion of the solid part of a Human femur, which has been steeped in an acid, dried, and preserved in oil of turpentine, to show the animal part. O. C. 117. *Hunterian.*

Development and Growth.

The following preparations are from the common Hog (*Sus scrofa*), and are the results of experiments made by feeding that animal on the root of madder (*Rubia tinctorum*), but they have now lost their colour.

- A. 97. The skull of a young Pig, slightly tinged. O. C. 190.

Hunterian.

- A. 98. A larger skull, more strongly coloured. O. C. 191.

Hunterian.

- A. 99. The right side of the lower jaw, in which the dentine of the teeth has retained more perfectly the red colour, whilst the enamel is of its ordinary whiteness; [a circumstance which was remarked by Mr. Belchier, the discoverer of this property of madder.—*Philos. Trans.* 1736, xxxix. p. 287.] O. C. 192.

Hunterian.

- A. 100. A longitudinal section of the humerus. The madder appears to have been remitted a short time before death, as there is a thin layer of uncoloured bone deposited on the external surface. O. C. 193.

Hunterian.

A. 101. A longitudinal section of the ulna, probably from the same animal as the preceding. O. C. 194. *Hunterian.*

A. 102. A longitudinal section of a metacarpal bone, in which an external layer of uncoloured bone may be observed, as in A. 100, being probably part of the same animal. O. C. 195. *Hunterian.*

A. 103. The os innominatum, in which a very slight tinge remains. O. C. 196. *Hunterian.*

A. 104. A longitudinal section of the femur of the same Hog as A. 100.

In this preparation may be observed a very thin layer of uncoloured bone deposited on the exterior of the shaft after the madder was remitted, and also some of the original uncoloured bone which had not been absorbed from the interior of the shaft when the animal was killed. O. C. 197.

Hunterian.

A. 105. A longitudinal section of the femur of an older Hog, in which the layers of bone deposited before, during, and after the administration of madder are more distinctly observable. O. C. 198.

[This preparation is figured in an original drawing by Wm. Bell, Mr. Hunter's Assistant.]

Hunterian.

A. 106. A longitudinal section of the femur of an older Hog, in which the coloured bone, deposited while the animal was under the influence of the madder, may be observed in some places to have reached the medullary cavity; the whole of the originally exterior uncoloured bone having been entirely absorbed at those parts. O. C. 199. *Hunterian.*

A. 107. A longitudinal section of the tibia of the same Hog as A. 100. It exhibits the same circumstances as are described in A. 100 and A. 104. O. C. 200. *Hunterian.*

- A. 108. A longitudinal section of the tibia of a younger Hog, with a thin exterior layer of coloured bone. O. C. 201.

By comparing this specimen with, and observing the size of the medullary cavity in, the preceding, the extent of the absorbing process will appear manifest; since the cavity is rendered sufficiently large to contain the entire bone of the earlier period of growth.

“In the formation of a bone, ossification begins in a spot, and gradually increases. By feeding an animal on madder, it is shown, that while bony matter is deposited on the outside of the bone, the absorbents are removing it from the inner side, otherwise the bone would become heavy and clumsy, and unfit for motion; therefore as the bony matter which was deposited becomes useless, nature removes it by the absorbents.”—*John Hunter, MS. Lectures.* See also “Experiments and Observations on the Growth of Bone, from the Papers of the late Mr. Hunter, by Everard Home, Esq., F.R.S.,” in the *Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge*, vol. ii. p. 277. Read Oct. 4, 1798.

The colouring-matter of madder has a great affinity to phosphate of lime, which, if artificially precipitated from a solution coloured with madder, carries down with it the colouring-matter in a state of combination which water does not disturb. The colouring principle of madder is very slightly soluble in water, but is abundantly so in albuminous fluid; and consequently is readily carried along with the circulating blood dissolved in the serum, and is deposited, combined with the phosphate of lime, wherever this salt is separated from the blood to contribute to the increase of reparation of bone. We may accordingly draw an inference as to the part of a growing bone which receives the accessions of osseous substance by observing the deposition of the madder-stained phosphate of lime.

Hunterian.

*Formation of Bone, exemplified in the Growth of the
Antlers of Deer.*

All the examples are from the Fallow Deer (*Cervus dama*).

- A. 109. A transverse section of part of the palm of the antler, while in a growing state, injected. O. C. 163.

The parts which invest the antler at this period are, a vascular membrane similar to periosteum and continued from the peri-

eranium, cutis and cuticle continued from the integuments of the head, and a particular kind of short downy hair, which gives it a velvety appearance.

Hunterian.

A. 110. The extremity of the palm of the antler, while in a growing state, injected. O. C. 164.

Hunterian.

A. 111. A transverse section of part of the palm of the antler, while in a growing state, injected, from which the outer velvet-like integument has been removed, to show the vascular periosteal membrane, part of which is turned back. O. C. 165.

Hunterian.

A. 112. A transverse section of part of the palm of the antler, while in a growing state, injected, to show its delicate cancellated structure, its vascularity at this period, and its periosteum, part of which is reflected from the bony substance. O. C. 166.

Hunterian.

A. 113. A horizontal section of part of the palm of the antler, while in a growing state, injected, and showing the same circumstances as the preceding preparation. O. C. 167.

Hunterian.

A. 114. The outer layer of bone and the periosteal covering of part of the palm, and of one of the branches of the growing antler, highly injected, and deprived of the earthy material by being steeped in acid, so that the ramifications of the vessels in the substance of the bone are more clearly shown. One of the external vessels of the periosteum derived from branches of the external carotid is also exposed. O. C. 168.

“ We find it a common principle in the animal machine, that every part increases in some degree according to the action required. Thus we find muscles increase in size when much exercised; vessels become larger in proportion to the necessity of supply, as for instance in the gravid uterus; the external carotids in the stag, also, when his horns are growing, are much larger than at any other time: and I have observed that in inflammation the vessels become larger, more blood passes, and there appear to be more actions taking place; but the nerves do not seem to

undergo any change. The nerves of the gravid uterus are the same as when it is in the natural state; neither do the branches of the fifth and seventh pair of nerves in the stag become larger.” —*Hunter, On the Blood*, 4to, 1794, p. 288.

Hunterian.

A. 115. A section of part of the palm of the antler, injected, stripped of its periosteum, and steeped in an acid, to show the high degree of vascularity in the substance of the bone at this period of its growth. O. C. 169. *Hunterian.*

A. 116. The other section, or counterpart, of the preceding specimen. O. C. 170. *Hunterian.*

A. 117. A small portion of the palm taken from the same antler as the preceding specimen, and prepared in the same manner. It is extremely vascular. O. C. 171. *Hunterian.*

The following seven preparations have been minutely injected, steeped in an acid, dried, and preserved in oil of turpentine, to show the vascularity of the substance of the growing antler.

A. 118. A longitudinal section of an antler, in which the longitudinal disposition of the fibres may be observed. O. C. 172. *Hunterian.*

A. 119. A similar specimen. O. C. 173. *Hunterian.*

A. 120. A similar specimen. O. C. 174. *Hunterian.*

A. 121. A transverse section of the palm of the antler, which gives to the internal structure a reticular appearance, in which part it may also be observed, that the blood-vessels are exceedingly minute, there being no large branches as on the external surface. See No. A. 114. O. C. 175. *Hunterian.*

A. 122. A similar specimen. O. C. 176. *Hunterian.*

A. 123. A small portion of the cancellated structure of the palm, cut in the direction of the fibres. O. C. 177. *Hunterian.*

- A. 124. A section of the outer compact substance of the palm.
O. C. 178. *Hunterian.*

- A. 125. A section of part of the os frontis and of the base of a Deer's antler, of which the growth was nearly completed.
O. C. 179.

It shows the antler to be a continuation of bone from the outer table of the skull, and the velvet-like covering of the antler to be equally continuous with the integuments of the head. It shows also the burr or pearl which has been formed round the base of the antler preparatory to the separation of the vascular integument of the antler from that of the skull.

In the formation of the burr, which is the last part of the process, and takes place rapidly, the osseous tubercles of which it is composed are projected outwards, and, by their pressure, induce absorption of the vascular external covering at that part. The cessation of the vascular action, or arrest of the unusual determination of blood to the antlers, is due to the same kind of constitutional and seasonal cause or influence as that which excited it: and, as the vessels diminish, the ossification of the burr encroaches upon their diminishing area; but it is not the mechanical cause of that diminution. The chief final purpose of the burr appears to be to defend the margin of the cranial integuments around the base of the antler. When the circulation through the carotids has returned to its normal state, the whole of that once very vascular and sensible tegument loses its vitality, dries, shrinks, and peels off, leaving the antler a naked insensible weapon.

In one of the branches (the brow antler) in this preparation, the whole of the vessels appear to have been thus obliterated: in the other a slight degree of vascularity remains, and one of the large external arterial branches is still uncompressed.

Hunterian.

- A. 126. A section of part of the os frontis and base of the antler, which has been completely formed and divested of its external tegument, or 'burnished,' as it is technically termed. This specimen has been injected, and steeped in an acid. O. C. 180. *Hunterian.*

- A. 127. A section of part of the os frontis and base of the antler, injected and steeped in an acid, to show the connection of

the horn with the skull, the loose spongy texture in the centre of the bone, and the outer, compact, last-formed layer. O. C. 181. *Hunterian.*

A. 128. A slice of the same parts as the preceding preparation, showing the same circumstances. O. C. 182. *Hunterian.*

A. 129. A transverse section of the beam of the same antler as A. 127, injected and steeped in acid, "showing the two stages of growth, and its becoming cellular in the centre." [This is the original description in the manuscript Catalogue; but Mr. Hunter, unfortunately, has not left any commentary or further explanation of his ideas respecting this specimen.] O. C. 183. *Hunterian.*

A. 130. A similar preparation. O. C. 184. *Hunterian.*

A. 131. A similar preparation. O. C. 185. *Hunterian.*

A. 132. A section of part of the skull and base of the antler, a short time previous to its being shed; injected and steeped in an acid. It shows the commencement of the interstitial absorption at the root of the antler, which renders that part soft and yielding; and also the separation of the outer, last-formed, compact layer of bone from the internal spongy part. O. C. 186. *Hunterian.*

A. 133. A slice of the same parts as the preceding preparation, which exhibits more clearly the progress of the interstitial absorption at the base of the antler. O. C. 187. *Hunterian.*

Development of other Bones.

A. 134. The cranium of a Human Fœtus (at about six months), showing the several places of commencement or centres of ossification, and the ossific matter deposited in fine bony fibres radiating therefrom. O. C. 132. *Hunterian.*

A. 135. The parietal bone of a Human Fœtus, showing its vascularity and the radiation of the osseous fibres from the centre. O. C. 162 A, *Mus, Sir Astley Cooper, Bart.*

- A. 136. One half of the frontal bone of a Human Fœtus, finely injected, and preserved in alcohol, showing its vascularity. O. C. 162 B. *Mus. Sir Astley Cooper, Bart.*

- A. 137. The vertebral column of a Human Fœtus of the sixth month, injected, showing the commencement of ossification in the bodies and arches of the vertebræ. O. C. 132 A.

The parts of the arches which are ossified are the two vertebral laminæ or “neurapophyses.” Ossification usually commences in the neurapophyses before it does in the centrum, viz. about the sixth or eighth week, by a single centre in each. The neurapophyses unite together first at the base of the spinous process, completing the arch in the first year after birth: in the course of the third year, the bases of the neurapophyses, which have extended into the centrum so as to form its neural angles, unite with the independently ossified part of the centrum. Prior to puberty, the following epiphyses exist, one flat plate forming each articular end of the centrum—a terminal epiphysis for the spine, another for the diapophysis, and a third for the metapophysis, where that process exists.

With regard to the atlas, the neurapophyses begin to be ossified as early as in the other vertebræ, but the so-called body does not begin to ossify until after birth. The neurapophyses unite together between the second and third years, and with the hypapophysis between the fifth and sixth years; the true body of the atlas, called “odontoid process,” begins to be ossified about the same time as the body of the dentata, viz. about the sixth month of fœtal life, but by two centres placed side by side, which unite together before birth. The proper centrum of the axis coalesces with that of the atlas about the fourth year. The pleurapophysis of the seventh cervical is formed from a separate osseous nucleus, at about the sixth month, which usually unites at one end with the centrum, at the other end with the diapophysis, about the fifth or sixth year.

The transverse processes of the first lumbar vertebra are sometimes developed from a separate centre, when they are “pleurapophyses” as long as they remain distinct: those of the other vertebræ are exogenously developed, and are “diapophyses.” As the pleurapophysial element homologically enters into the formation of the hole in the transverse process of the cervical vertebræ, but is autogenously developed only in the seventh, the pleurapophysis

becomes thus occasionally exogenous in the neck, as the neurapophysis does in the tail.

In the sacrum, besides the ossous nucleus for the centrum, and for each neurapophysis, one for each pleurapophysis commences about the sixth month close to the fore part of each nervous interspace, in the three anterior vertebræ; the lowest appearing last, about the ninth month: the junction of the neurapophyses to form the arch begins in the lowest vertebra first, viz. about the second year, but the first sacral vertebra is not a single piece before the fifth or sixth year. About the sixteenth year the sacral vertebræ begin to coalesce, and the fourth and fifth are usually united by the eighteenth year, the process of union gradually proceeding upwards: the terminal epiphyses of the sacral centrum are formed as in the true vertebræ; and lateral epiphyses, also, begin to form, one for the ends of the pleurapophyses of the first two vertebræ, and one for those of the last three. The whole sacrum is not consolidated till about the thirtieth year.

Each coccygeal vertebra is ossified from a single centre.

Presented by William Lawrence, Esq.

A. 138. The vertebral column of a mature Human Fœtus. The ligamentum commune anterius has been removed, to show the intervertebral substances, which are composed largely of concentric ligamentous fibres, passing between and connecting the whole of the articular surfaces of the bodies of the vertebræ, as is exhibited in the preceding specimen. The articular processes are connected by another mode of articulation, where opposed cartilaginous articular surfaces are simply in contact, being connected to each other by a capsular ligament and synovial membrane.

The pleurapophysis has been preserved on the left side of the seventh cervical vertebra. The summits of the neurapophyses are joined by cartilaginous rudiments of the neural spine. Short cartilaginous pleurapophyses extend from the diapophyses of the lumbar vertebræ. They have begun to be ossified in the first three sacral vertebræ.
O. C. 247. *Hunterian.*

A. 139. The sternum of a Human Fœtus of the sixth month, exhibiting the commencement of ossification by four separate points or centres; that of the manubrium, or first bone,

has been removed from the cavity in which it was imbedded.
O. C. 132 B. *Mus. Heaviside, No. 90.*

A. 140. The sternum and sternal ribs of a Human Fœtus of the sixth month, injected, dried, and preserved in oil of turpentine. Four centres of ossification are established in the sternum, representing the ventral spines of the first four thoracic segments of the skeleton. O. C. 132 c.

Mus. Sir Astley Cooper, Bart.

A. 141. The sternum and sternal extremities of the true ribs of a mature Human Fœtus. Four separate points of ossification may be observed in the sternum. O. C. 133. *Hunterian.*

A. 142. The sternum of a Child at an early period of life, showing vessels from the internal mammary arteries, ramifying on the several separate ossifications. O. C. 134. *Hunterian.*

A. 143. The left humerus of a new-born Leopard (*Felis pardus*), showing the cartilaginous epiphyses: the lower one is extended over the division of the inner condyle, and closes there the fissure through which the brachial artery and median nerve pass; which fissure, by subsequent ossification and confluence of the distal epiphyses, is converted into a foramen. O. C. 133 F.

A. 144. A section of the proximal extremity of the humerus of a young person, showing the reticular cancellous structure of the epiphysis, and of the extremity of the diaphysis of the bone. O. C. 204. *Hunterian.*

A. 145. The counterpart of the preceding preparation. O. C. 205. *Hunterian.*

A. 146. Longitudinal sections of the extremities of a Human humerus, radius, and ulna, from a subject aged 15 years. O. C. 205 A. *Presented by A. H. Tubby, Esq.*

A. 147. A section of the epiphysis of a metacarpal bone of a Calf, showing ossification beginning in several parts of the cartilage. O. C. 139. *Hunterian.*

- A. 148. A similar preparation. O. C. 140. *Hunterian.*
- A. 149. Another section, to show further progress of the ossification. O. C. 141. *Hunterian.*
- A. 150. A section of the epiphysis of the shank-bone of a Calf, in which ossification is chiefly advancing from the centre. O. C. 142. *Hunterian.*
- A. 151. A section of the epiphysis of a metacarpal bone of the same animal, injected: with a more distinct centre of ossification. O. C. 143. *Hunterian.*
- A. 152. Another section, with the ossification more advanced. O. C. 144. *Hunterian.*
- A. 153. The cartilage of an epiphysis, with the central ossification well-injected, showing that it is much more vascular than the surrounding cartilage. O. C. 145. *Hunterian.*
- A. 154. A similar preparation. O. C. 146. *Hunterian.*
- A. 155. A similar preparation, with the ossification in its centre more advanced. O. C. 147. *Hunterian.*
- A. 156. A section of temporary cartilage. The large vessel which traverses the preparation probably lies in the interspace of two adjoining epiphyses. O. C. 148. *Hunterian.*

The following preparations have been injected, steeped in an acid, dried, and preserved in oil of turpentine, to show the vascularity of growing bone.

“Parts whose use in the machine may be said to be passive, as tendon, cellular membrane, ligaments, investing membrane, bone, and cartilage, which last is probably the most passive, have all small vessels, and of course but few that are visible. As bone, however, is composed of two parts, viz. animal substance and earth, it is probable that there may be more action required to form the latter than either tendon or cartilage, and therefore there will be more vessels.

“As a further proof that this is a general principle, we find that

all growing parts are much more vascular than those that are come to their full growth ; because growth is an operation beyond the simple support of the part : and this is the reason why young animals are more vascular than those that are full-grown."—"This is known by injections, when parts are in the growing state, or are just grown, and for some time after."—*Hunter, On the Blood*, 4to, 1794, p. 156.

- A. 157. A transverse section of the epiphysis of a cylindrical bone, which exhibits the progress of the vessels from the circumference towards the centre. O. C. 149. *Hunterian*.
- A. 158. A section of the metacarpal bone of a Calf. O. C. 152. *Hunterian*.
- A. 159. A similar section of the metacarpal bone of a Calf. O. C. 153. *Hunterian*.
- A. 160. A vertical and longitudinal section of one of the toes, finely injected, of a foetal Calf (*Bos taurus*). It shows the large cartilaginous epiphysis of the metacarpal bone, and the highly vascular ossific centres of the three phalanges. The sesamoid is cartilaginous. O. C. 133 H.
Mus. Sir Astley Cooper, Bart.
- A. 161. The pelvis of a (female) mature Human Fœtus, showing the radiating disposition of the ossific fibres in the ilium, and the separate points of ossification in the ischium and pubes, and in the bodies and neurapophyses of the sacral vertebræ. The coccyx is still wholly cartilaginous. O. C. 133 A. *Presented by W. H. Clift, Esq.*
- A. 162. The right femur of a foetal Leopard, showing the cartilaginous epiphysis of the head, the great trochanter, and the condyles. O. C. 133 G.
- A. 163. The femur of a mature Human Fœtus, showing the cartilaginous epiphyses ; the superior of which comprehends the great and little trochanter. O. C. 133 B.
Presented by W. H. Clift, Esq.

- A. 164. A small section of bone, while in a growing state ; apparently the outer crust of a tibia of a *Sus scrofa*. O. C. 158. *Hunterian.*
- A. 165. A similar preparation. O. C. 159. *Hunterian.*
- A. 166. A transverse section of an epiphysis [probably from the leg of a foetal Calf (*Bos taurus*)], the ossification of which is nearly completed. O. C. 150. *Hunterian.*
- A. 167. A similar preparation. O. C. 151. *Hunterian.*
- A. 168. A longitudinal section of the tibia of a Calf. O. C. 160. *Hunterian.*
- A. 169. The tibia of a mature Human Fœtus, showing the cartilaginous epiphyses. O. C. 133 c.
Presented by W. H. Clift, Esq.
- A. 170. A transverse section of the tibia of a young Man, exhibiting its degree of vascularity. O. C. 161. *Hunterian.*
- A. 171. A section of the lower part of a Human tibia, in which the degrees of vascularity of the epiphysis, the cancellous extremity, and denser part of the shaft of the bone may be compared with each other. O. C. 162. *Hunterian.*
- A. 172. A section of the diaphysis of a Human tibia, injected; exposing the medullary cavity, and the vessel of the marrow (Arteria medullaris), ramifying on the lining membrane of the cavity. O. C. 209 A.
Presented by William Lawrence, Esq.
- A. 173. Sections of the extremities of right femur, tibia, and fibula, from a subject aged 15 years.
Presented by A. H. Tubby, Esq.
- A. 174. The upper extremity of the tibia of a Child, having the patella attached. The arteries of the cartilaginous

patella are injected, but ossification had not yet begun.
O. C. 135. *Hunterian.*

A. 175. The patella of a Child more advanced in age, in which ossification has begun in the centre, and has extended along the coats of the arteries, making them appear like bony ramifications. O. C. 136. *Hunterian.*

A. 176. A series of three Human patellæ of different periods of growth, to show the progress of ossification. O. C. 137. *Hunterian.*

A. 177. A section of the astragalus of a young person, exhibiting the reticular cancellous structure of the whole bone, the cancelli being largest in the centre. O. C. 206. *Hunterian.*

A. 178. The counterpart of the preceding preparation. O. C. 207. *Hunterian.*

A. 179. The os naviculare of a young person, longitudinally bisected, to show the cancellous structure nearly uniform throughout the bone. O. C. 208. *Hunterian.*

A. 180. The os cuneiforme internum of a young person, longitudinally bisected, and showing a similar structure. O. C. 209. *Hunterian.*

A. 181. The two middle metatarsal bones of a Pig (*Sus scrofa*), in section. The vascularity is greatest at the spongy extremities. O. C. 157. *Hunterian.*

A. 182. A longitudinal section of the metatarsal bones of a Calf. Along the middle of this preparation may be observed the progress of the ossification, which afterwards produces a complete ankylosis, and reduces the two to a single cannon-bone. O. C. 154. *Hunterian.*

A. 183. A similar preparation; apparently a section of the preceding specimen. O. C. 155. *Hunterian.*

- A. 184. The exterior section of the same bones. The vessels in the cartilaginous extremity are particularly distinct. O. C. 156. *Hunterian.*
- A. 185. A metatarsal cartilage of a Calf, injected. The arteries in several parts are of a whitish colour, from a deposit of calcareous earth. O. C. 138. *Hunterian.*
- A. 186. A section of the foot of a mature Human Fœtus, injected, showing the cartilaginous condition of the bones of the tarsus, with the commencement of ossification in the os calcis and astragalus. O. O. 133 D.
- A. 187. Section of the foot of a Boy 12 years of age, showing the epiphyses of the lower part of the tibia, os calcis, metatarsal and phalangeal bones, injected. The section is through the middle of the first metatarsal bone. O. C. 133 D a. *Presented by J. Hilton, Esq.*

BONES CONTAINING GAS OR AIR.

- A. 188. Greater part of the crania of two Herrings (*Clupea harengus*), showing their ventral surfaces. In A the surface has been left entire; in B some bone has been removed to show the three bony chambers on either side that lodge an extension of the swim-bladder. Into the anterior of these chambers extends a process of the membranous labyrinth. On the right side of B the chambers have been opened, and have bristles passed into them. A portion of the anterior extremity of the swim-bladder has been retained and painted black. These gas-filled cavities probably serve as resonating chambers subservient to hearing.

Ridewood, J. of Anat. & Physiol., vol. xxvi. 1892, p. 26.

- A. 189. Posterior portion of the skull of a Crocodile (*Crocodilus acutus*), with part of left ramus of the lower jaw attached. A piece of the skull has been removed to show the interior of the tympanic cavities which freely communicate with one another above the brain-case. This may perhaps serve

as a resonating chamber connected with hearing, and as a protection to the brain-case. The Eustachian tubes by which the tympana open into the pharynx (*vide* Sect. E) are very complicated, they have three openings on the ventral surface of the skull. Through the unpaired opening blue bristles have been passed into the tympana, and black through the paired. A special passage extends through the inner border of the quadrate bone, and is continued as a membranous tube (siphonium) to an opening in the articular bone of the lower jaw, by this the bone becomes pneumatic. A red bristle has been passed through each of these passages, but the siphonium is not preserved. On the left side the columella auris and part of the membrana tympani is shown.

van Beneden, Arch. de Biol., t. iii. 1882, p. 497.

A. 190. Skull of a Rook (*Trypanocorax frugilegus*). The outer wall of the skull has been removed on the left side, exposing a cavity that was occupied by medulla. A portion of the inner wall of this cavity has been removed to show the air-containing chamber. The articular bone of the lower jaw has had its air-chambers exposed, the air being received by means of a bony tube (siphonium) that opens into the tympanic cavity; a bristle has been passed through the siphonium.

A. 191. A longitudinal section of two anterior dorsal vertebræ of an Ostrich (*Struthio camelus*), showing the delicate reticular structure of the entire substance of these bones for receiving air, which enters by apertures near the roots of the transverse processes. O. C. 214. *Hunterian.*

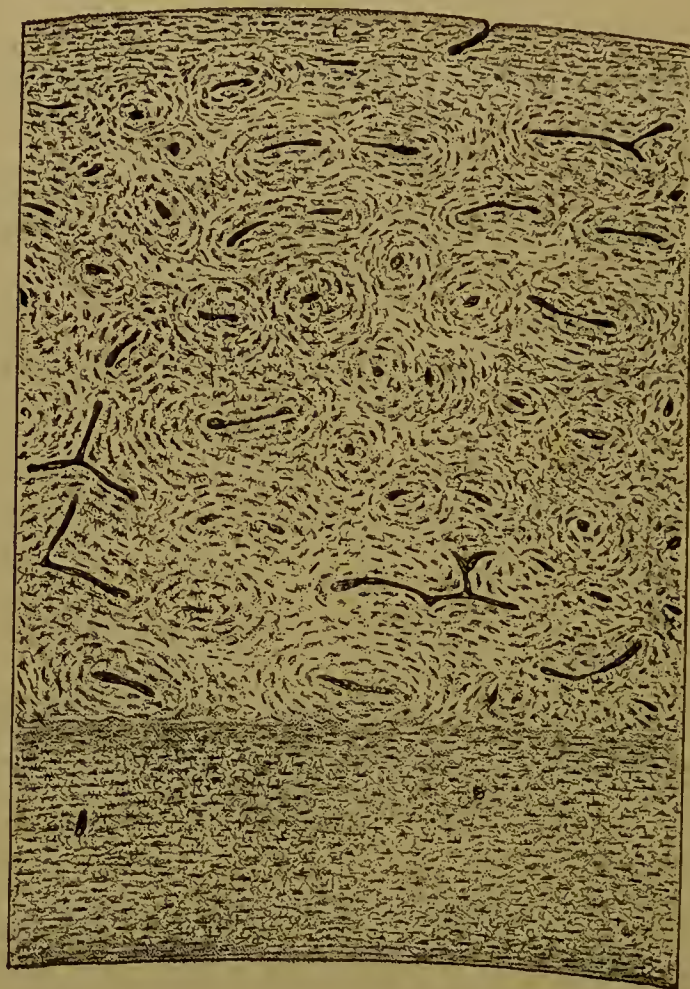
A. 192. The os humeri of an Owl, which shows the cavity free from marrow, and cancellated only at the extremities, and therefore a good receptacle for air. Near to the joint of the shoulder may be observed the aperture by which the air passes into the cavity. O. C. 210.

“In most birds, I believe in all that fly, these axillary cells communicate with the cavity of the os humeri by means of small openings in the hollow surface near the head of that bone: in

some they are continued down the wing, communicating with the ulna and radius; in others they reach even as far as the pinions. The ostrich, however, is an exception:” [*i. e.* has no air even in the humerus.]—*Hunter, On the Animal Economy*, 4to, p. 92.

Hunterian.

Fig. 3.



Humerus of an Eagle, showing the common lamellæ well developed on its medullary surface, but only slightly on its periosteal. A condition usually present in air-containing bones. Trans. sect. $\times 20$.

- A. 193. The os humeri of a Silk-fowl (*Gallus ferrugineus*, var. *morio*) longitudinally bisected, to show the cavity for containing air, and the passage by which it enters, indicated by a bristle. O. C. 213.

“The bones which receive air are of two kinds: some, as the sternum, ribs, and vertebræ, have their internal substance divided into innumerable cells; whilst others, as the os humeri and the os

femoris, are hollowed out into one large canal, sometimes with a few bony columns running across at the extremities. Bones of this kind may be distinguished from those that do not receive air by several marks: 1st, by their less specific gravity; 2ndly, by being less vascular than the others, and therefore whiter; 3rdly, by their containing little or no oil, and consequently being more easily cleaned, and appearing much whiter when cleaned than common bones; 4thly, by having no marrow, nor a bloody pulpy substance, even in their cells; 5thly, by their not being, in general, so hard and firm as other bones; those of some birds are so soft, that they can be squeezed together with the finger and thumb; however, the bones of the extremities have very solid sides; 6thly, the passage by which the air gets into the bones can be easily perceived, even in cleaned bones. Generally there are several holes placed together near the end of the bone which is next the trunk of the bird; and distinguishable by having their external edges rounded off, which is not the case with those holes through which either nerves or blood-vessels pass into the substance of the bone.”
—*An Account of certain Receptacles of Air in Birds, by John Hunter, Phil. Trans. 1774, lxiv. p. 205.*

“In the common fowl no air appears to enter any bone except the os humeri.”—*Hunter, On certain Receptacles of Air in Birds, ut supra, p. 210.*

Hunterian.

- A. 194. A section of the upper extremity of the femur of an Ostrich, showing its cellular structure for containing air. A bristle is passed through the aperture by which the air enters. O. C. 215.

Hunterian.

- A. 195. A section of the upper extremity of the femur of a young Ostrich, showing its cellular structure, and the aperture by which the air enters the cavity of the bone. O. C. 216.

Hunterian.

- A. 196. A section of the lower extremity of the femur of a young Ostrich, showing its cellular structure for containing air. O. C. 217.

Hunterian.

- A. 197. Cranium of a Koala (*Phascolarctus cinereus*). A large alisphenoid bulla (=thin-walled projecting bony chamber

filled with air) is connected with the tympanum ; that of the right side has been opened. Red bristles show the course of the Eustachian tubes and their openings into the posterior ends of the bullæ. A cavity in the base of the zygoma and mastoid process of the squamosal opens into the tympanum ; it is partly closed by the skin on the dorsal wall of the meatus ; a black bristle has been passed into it from the bulla. These air-chambers render the bone light, and may act as resonating chambers associated with hearing.

Paulli, *Morph. Jahrb.*, Bd. xxviii. 1899, p. 147.

- A. 198.** Cranium of a Chinchilla (*Chinchilla lanigera*). Each tympanum has two bullæ—one ventral and one dorsal. The ventral is of large size ; it extends backwards and upwards to half the height of the skull : red bristles are inserted into the Eustachian openings. The dorsal bulla, indicated by a black bristle, commences as a diverticulum of the tympanic roof close to the membrana tympani ; it passes upwards on the inner side of the meatus, forms a flattened projection on the dorsal surface of the skull, and extends backwards and downwards to meet the ventral bulla, from which it is separated by a bony septum. The dorsal bulla is said to be formed in the periotic bone ; the ventral either in the tympanic or in a special cartilage.

Presented by F. G. Parsons, Esq.

- A. 199.** Left half of the cranium of a Horned Sheep (*Ovis aries*), showing the air-filled cavities in the bones that communicate either with the nasal chamber or tympanum. The frontal sinus and its communication with the nasal cavity is indicated by a black rod ; this sinus extends into the horn-core. A blue rod has been passed into the middle meatus of the nose from the large cavity in the superior maxilla (antrum of Highmore). A red rod indicates the Eustachian opening into the tympanum. The floor of the tympanum is expanded into a bulla of less size than in the Carnivora, and possesses no septum.

The bullæ may serve as resonating chambers connected

with audition. The frontal sinuses give lightness to the bone and protection to the brain; the antrum making the superior maxilla light.

- A. 200. Cranium of a Cat (*Felis domestica*). Red bristles have been passed in the direction of the Eustachian tubes into the tympana. A black bristle from the left frontal sinus through a curved passage to its opening in the middle meatus of the nose. A green bristle from the left sphenoidal cell formed in the presphenoid into the postero-inferior region of the nose. The tympanic element of the temporal bone has given origin by its entotympanic portion to a large tympanic bulla partly separated by a bony septum from the true tympanum.
- A. 201. The two halves of a transverse section of a Cat's cranium (*Felis domestica*). Similar bristles have been introduced into the air-containing chambers.
- A. 202. Left half of a Human cranium, similarly treated; a white bristle has also been passed into the mastoid cells.
- A. 203. Transverse section of a Human cranium. The frontal and maxillary air-chambers are shown.

B.

FLEXIBLE BONDS OF UNION AND SUPPORT.—
VERTEBRAL COLUMN.—JOINTS.

FLEXIBLE BONDS OF UNION AND SUPPORT.

AREOLAR TISSUE.

- B. 1. Small portion of skin and subjacent structures of a Calf (*Bos taurus*), showing the areolar tissue that unites them. It consists mainly of delicate wavy bundles of tough, flexible, inextensible and inelastic white fibrous tissue, loosely interlaced so as to allow of motion in any direction. The return to the position of rest is effected by fine branched fibres of yellow elastic tissue.

Above is a piece of separate areolar tissue.

SPECIAL ELASTIC STRUCTURES.

Loisel, Jour. de l'Anat. et Physiol., t. xxxiii. 1897, p. 129.

Not essentially connected with the Skeleton.

- B. 2. Portions of three specimens of Scallop (*Pecten maximus*), showing the two ligaments by which the valves are attached to one another. The external ligament is structureless and inelastic; it extends along the straight hinge-line, but is interrupted near its middle by the internal ligament. The internal ligament is a wedge-shaped black mass, lodged in a depression of the shell; it grows by additions to its ventral border; being very elastic, and compressed when the adductor muscle contracts, it acts like a spring, keeping the valve apart in the most constant feeding-position of the animal, and also acts as an opponent of the muscle by which swimming is effected.

Quekett, Trans. Micro. Soc., vol. ii. 1849, p. 1.

- B. 3. A portion of the elastic ligamentous substance from the belly of an Elephant (*Elephas indicus*). O. C. 74.

“On the abdomen of most quadrupeds are to be found elastic ligaments, especially on that of the elephant, which is a constant

support to the parts in their horizontal position ; and even the cellular membrane of the elephant has a degree of elasticity much above what is generally met with in cellular membranes. Hence there is less expense of muscular contraction in such parts.”—*Hunter, On the Blood*, 4to, p. 111.

Hunterian.

- B. 4. Posterior portion of the ventral walls of the abdomen of a Horse (*Equus caballus*). The skin has been in part removed to show the “tunica abdominalis.” This consists of two layers: the superficial is composed of bundles of yellow elastic fibres that extend from the posterior ribs and cartilages to the pelvic brim. The deep layer consists of white fibrous tissue, the fibres being directed outwards and forwards. The tunica abdominalis gives firm support to the heavy abdominal viscera ; it is defective in the mid line, which probably favours the changes in bulk of the viscera.

Presented by Prof. McFadyean.

- B. 5. Two sections of abdominal wall of a Horse (*E. caballus*) showing the position of its layers, viz., skin, subcutaneous tissue, tunica abdominalis, muscle, fat, peritoneum.

Presented by Prof. McFadyean.

Connected with Vertebral Column.

SUPRASPINOUS.

- B. 6. Two portions of the vertebral column of a Fox-Shark (*Alopias vulpes*) showing, from the side and in transverse section, a continuous band of yellow elastic tissue (the supraspinous elastic ligament) surmounting the dorsal arches.
- B. 7. Anterior portion of the vertebral column of a Shark (*Notidamus griseus*). A round continuous cord of yellow elastic tissue commences in a point immediately behind the head and extends the whole length of the column, closely adherent to the cartilaginous spinous processes.
- B. 8. A supraspinous elastic ligament is said to be present in a Brazilian bird (*Lamprotes loricatus*). A specimen is much wanted.

- B. 9.** Back of the skull, with cervical and four dorsal vertebræ, of a Sheep (*Ovis aries*), showing the (ligamentum nuchæ) supraspinous elastic ligament. It consists of two rounded bundles of yellow elastic tissue fused in the mid line, attached in front to the occipital tubercle, and strengthened by a broad bundle springing from the spines of the 2nd, 3rd, 4th, and 5th vertebræ. The two bundles becoming flattened extend backwards as far as the sacrum, greatly diminishing in size. They are attached to the neural spines, especially those of the anterior dorsal vertebræ. This ligament serves as an elastic support to the head and neck.
- B. 10.** A similar preparation from a Dog (*Canis familiaris*). The ligament springs as a round cord from the posterior angle of the spinous process of the second vertebra. It passes backwards without further attachment in the neck, and is fixed to the tips of the spines of the dorsal and lumbar vertebræ. This arrangement appears to give to the head greater freedom for movement.

INTERSPINOUS.

- B. 11.** Five dorsal vertebræ of a Crocodile (*Crocodylus acutus*), with portions of ribs attached. The spinous processes are united by yellow elastic tissue, forming an interspinous elastic ligament.
- B. 12.** Three inferior cervical vertebræ of an Ostrich (*Struthio camelus*) showing the deep interspinous elastic ligament.
- B. 13.** Cervical vertebra of an Ostrich (*Struthio camelus*). The spinous process has been removed to show the attachments of the elastic ligaments.
- B. 14.** Three dorsal vertebræ of an Ostrich, longitudinally bisected, to show a similar disposition of elastic ligament between the spinous processes of this part of the vertebral column. O, C. 72, *Hunterian*,

- B. 15.** Portion of the vertebral column together with part of the skull and pelvis of a Maguari Stork (*Euxenura maguari*), showing a series of interspinous elastic ligaments. The ligaments extend between the neural spines from the axis to the anterior end of the sacrum. They vary very greatly in size in different regions of the vertebral column; from the first ligament (3 mm. diameter) they gradually diminish and reach their minimum (1 mm. diameter) between the 6th and 9th vertebræ, they then again increase in size and attain their maximum (6 mm.) between the 13th and 17th. From the 17th vertebra onwards the ligaments are divided into a superficial and deep series (Lig. elastica profunda and superficialia). They increase in size from before backwards, *i. e.* from 2 mm. and 3 mm. diameter to 5 mm. and 6 mm. respectively.

Barkow, Syndesmologie der Vögel, 1856, p. 32.

SUBSPINOUS.

- B. 16.** Head and vertebral column of a Sterlet (*Acipenser ruthenus*) showing a subspinous elastic ligament. The ligament originates at the back of the skull within the mass of cartilage formed by the fusion of the five anterior dorsal arches, and extends from that point to the tail with slight lateral attachments to each arch. It lies throughout its course between the upper ends of the dorsal arches, cut off by cartilage from the neural canal. A subvertebral elastic ligament is also present, projecting like a "typhlosole" into the lumen of the dorsal aorta; it extends from the base of the cranium to the tail, and may be considered as a modification of the aortic wall, with function subsidiary to circulation. Black bristles have been inserted between the subspinous ligament and the vertebral column, and blue rods between the subvertebral ligament and vertebral column.

- B. 17.** The vertebral column and part of the cranium of a Shad (*Clupea alosa*), showing two similar elastic ligaments. Though in their general features the ligaments resemble those of the Sterlet, they both show a remarkable development in the anterior region, the ventral ligament in

particular being so taut and powerful that the vertebral column, even before the removal of the trunk-muscles, is bent into serpentine curves. Towards the tail both ligaments are reduced in size.

- B. 18.** Two transverse sections of the vertebral column of a Shad (*Clupea alosa*), taken from the trunk (upper specimen) and tail regions respectively, to show the relations of the sub-vertebral ligament to the aorta.
- B. 19.** Anterior portion of the vertebral column, and posterior part of the cranium of a Cod (*Gadus morrhua*), showing the powerful subspinous ligament. It is partly attached to the arches, as shown in the lower part of the preparation by the removal of the left halves of two of the arches.
- B. 20.** Four vertebræ of a Cod (*Gadus morrhua*) giving an end view of the ligament.

INTERARCUAL.

- B. 21.** Seven dorsal neural arches and spines of a Sheep (*Ovis aries*) showing the yellow elastic tissue (Ligamenta subflava) by which the arches are united. Its probable duty is to reestablish the normal curves of the spine after muscular action.

AT VERTEBRAL JOINT OF RIBS.

- B. 22.** Six vertebræ of a Snake (*Python sebae*), with portions of the ribs left attached to the lower three. In front of the joint

Fig. 4.



× 20.

the attachment of the rib to the vertebra is effected by a plate of yellow elastic tissue, the elastic fibres are closely packed, parallel to one another, at its fixed ends cartilage

matrix and cells are abundant, the fibres terminating in a network after repeated branching. The ligament probably serves to drag the rib forward after the contraction of the intercostal muscles has pulled it backwards. The ligament has been left attached to the vertebræ from which the ribs have been removed. (Fig. 4.)

LIMBS.

- B. 23. Right pectoral fin of a Monk-fish (*Rhina squatina*), showing a series of elastic ligaments situated upon the ventral surface of the fin. The largest and most important of these ligaments (indicated by a black bristle) connects the shoulder-girdle with the two anterior basal pterygia; it lies outside the joint capsule. The remainder of the series are related in a similar manner to the basio-radial and proximal row of interradial joints. On their inner side they are in close connexion with the interarticular fibrous mass and covered on the outside by the perichondrium. No such ligaments are present on the dorsum of the fin. A similar condition was found in *Acanthias*, but not in *Myliobatis* or the Skate.
- B. 24. A longitudinal section through the mesopterygium, a radius, and part of the shoulder-girdle of a Monk-fish (*Rhina squatina*), showing the elastic ligament that connects the shoulder-girdle with the ventral surface of the pterygium and its relations to the joint capsule. The capsule has been removed from the dorsal surface of the joint.

JOINTS.

Without known function, mostly the result of periodicity in rate or nature of growth.

PLANTS.

- B. 25. Terminal branch of a Euphorbia (*E. neriiifolia*) stained by cupric acetate. The stem is jointed, showing a series of constrictions. The joints do not increase the flexibility of the stem, nor serve as places of ready fracture as in Cacti. They probably only indicate periodicity in growth, and have no function. The terminal segments bear large leaves.

Royal Gardens, Kew.

- B. 26. A similar specimen of *E. lactea*. The leaves in this plant are minute and borne on the edges of the angular jointed stem. They are soon lost, their duty being performed by the succulent green stem. *Royal Gardens, Kew.*
- B. 27. A similar specimen of *E. globosa* having two flower-bearing branches. As in the former specimen the leaves are minute, soon lost, and borne only on the last formed segments of the stem, the jointed character of which is very marked. *Royal Gardens, Kew.*

ANIMALS.

- B. 28. Hydroecium of a Hydroid zoophyte (*Aglaophenia myriophyllum*), with a drawing of the structure of its stem (hydrocaulus). The stem is composed of about seven or eight tubes uniformly arranged in the internodes, but that divide into two bundles at the nodes where they are arranged in one plane. This allows of movement through about 40° at the oblique surface of the node.
Hincks, Brit. Hydroid Zoophytes, vol. i. p. 290.
- B. 29. Portions of a Fan-coral (*Melitodes ochracea*). From one piece the crust has been removed. Another is in section. The axis is divided into a series of nodes and internodes. At the nodes the spicules forming the axis are loosely arranged, partly fused together at their extremities, or united by a small amount of horny matter. The jointed character of the axis does not increase its flexibility, and apparently only indicates a periodic change in its nature.

Joints (=nodes), points of development of organs, separated by internodes that effect the necessary elongation.

PLANTS.

- B. 30. *Nitella flexilis*, with drawing of the minute structure of growing end. The stem consists of greatly elongated cells, each forming an internode, their protoplasm is reduced to a thin layer lining the cell-wall, abundant cell-sap occupying the interior; the nucleus has disappeared by fragmentation.

In the nodes the cells are small, filled with protoplasm, and retain their nucleus. From the nodes are developed all organs and accessory parts. *Presented by H. Groves, Esq.*

- B. 31. Portion of the stem of *Equisetum maximum* with whorls of branchlets cut short. The stem is hollow from the more rapid growth of the circumference than the centre. It is jointed, being divided into nodes from which the branchlets spring, and from which all organs are formed. At the nodes the vascular bundles communicate with one another, and a septum is formed across the cavity of the hollow stem.
Royal Gardens, Kew.

- B. 32. Three portions of the stem of Wheat (*Triticum vulgare*), with leaves attached. The stem is hollow from the rupture of the pith. At the nodes a septum separates the neighbouring cavities ; at this point the vascular bundles of the leaf (veins) are continued into those of the stem (cauline bundles).
Presented by Prof. C. Stewart.

- B. 33. Terminal branch of Yellow Jasmine (*Jasminum nudiflorum*). The stem is solid owing to the pith not being ruptured. The insertions of the leaves indicate the nodes.
Presented by Prof. C. Stewart.

JOINTS THAT ALLOW OF CONTINUOUS GROWTH.

ANIMALS.

- B. 34. Two specimens of the test (corona) of an Echinus (*E. acutus*). They are about half-grown. One has been bisected, the other has had the five sets of ambulacral, and five sets of interambulacral plates detached. One of each of these has had each plate separated. There are 82 plates in each ambulacrum, and 46 in each interambulacrum ; the total number in the test, including the 10 apical plates, being 650. Each plate enlarges by additions to its borders their number being increased by the formation of fresh plates at the apex of the test.

Presented by Prof. C. Stewart.

- B. 35. A Trunk-fish (*Ostracion quadricornis*). The greater part of its body is protected by hexagonal bony plates that increase in size by additions to their margins.
- B. 36. Separated bones of the carapace and plastron of a Tortoise (*Damoniea reevesii*). The bones are mostly of dermal origin, and are suturally attached to one another. Growth is effected at the sutural margins.
- B. 37. Cranium from a child aged about 9 years. It is composed of separate bones united suturally. Increase in size is effected by additions to their edges, so that the capacity of the skull may keep pace with the growth of the brain. The adult size of the cavity in the frontal region is attained in the second year, the posterior region at a somewhat later period. The position of obliterated sutures are indicated by blue dots.

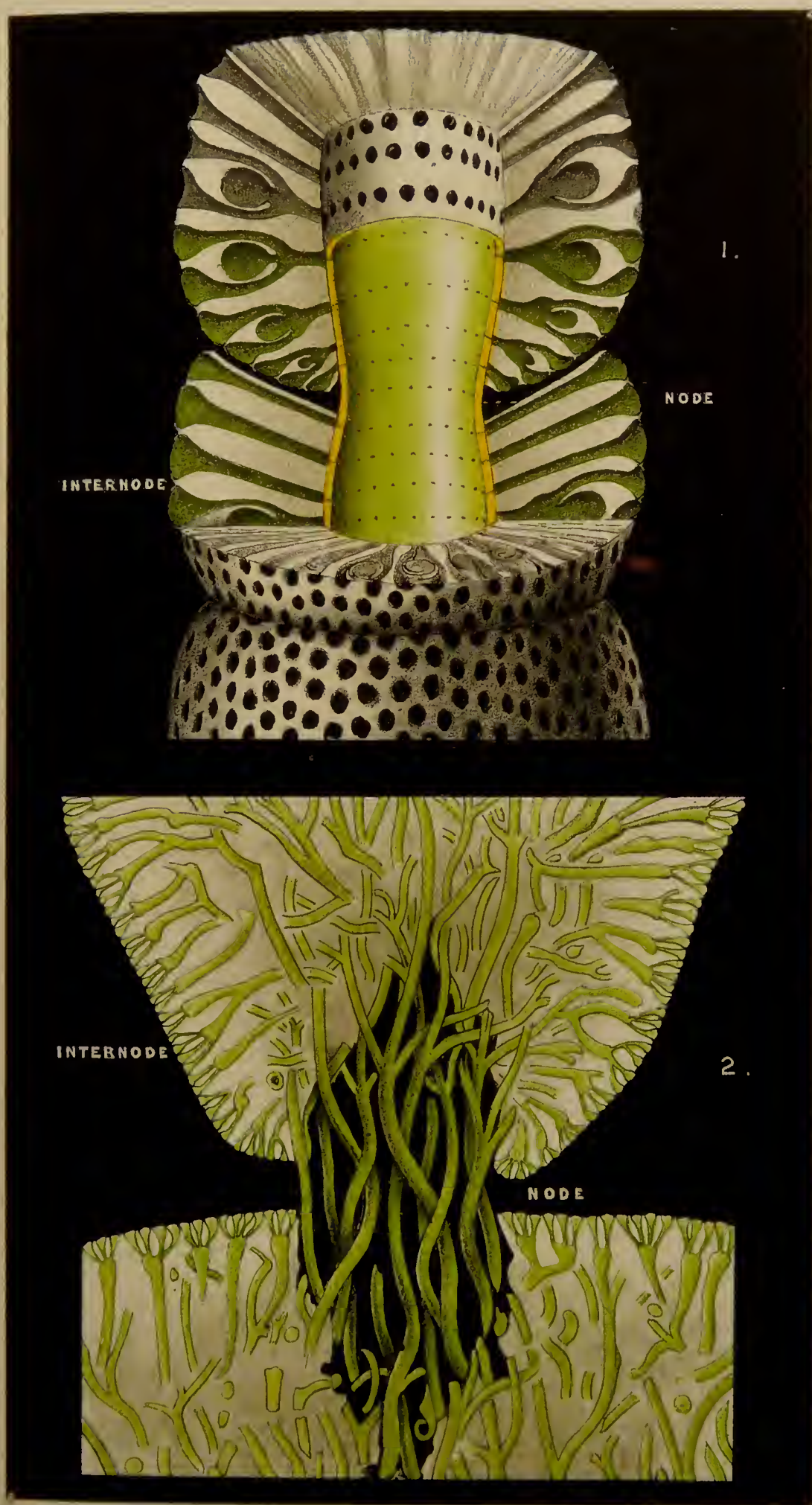
Merkel, Beitr. z. Anat. u. Embryol. als Festgabe zum Henle, 1882, p. 164.

Joints that by allowing motion, diminish the risk of fracture.

PLANTS.

- B. 38. A multinucleate calcareous Alga (*Cymopolia barbata*), with a drawing of its structure. Each branch of the thallus consists of a central tube of cellulose lined by chlorophyll-containing protoplasm. It is slightly constricted at short intervals. The constricted part (node) is flexible. The internodes bear whorls of lateral branchlets, those at the proximal end being short, but increasing in length to the distal end. Between the branchlets carbonate of lime is deposited, rendering the internode rigid. The flexibility at the node greatly diminishes the risk of fracture. This plant is found on the shores of the Tropical Atlantic. Pl. IX. fig. 1. Presented by G. R. M. Murray, Esq. Cramer—Ueber die verticillirten Siphonen (*Neomeris* und *Cymopolia*).

- B. 39. A similar specimen and drawing of another calcareous multinucleate Alga (*Halimeda tuna*). The fan-shaped



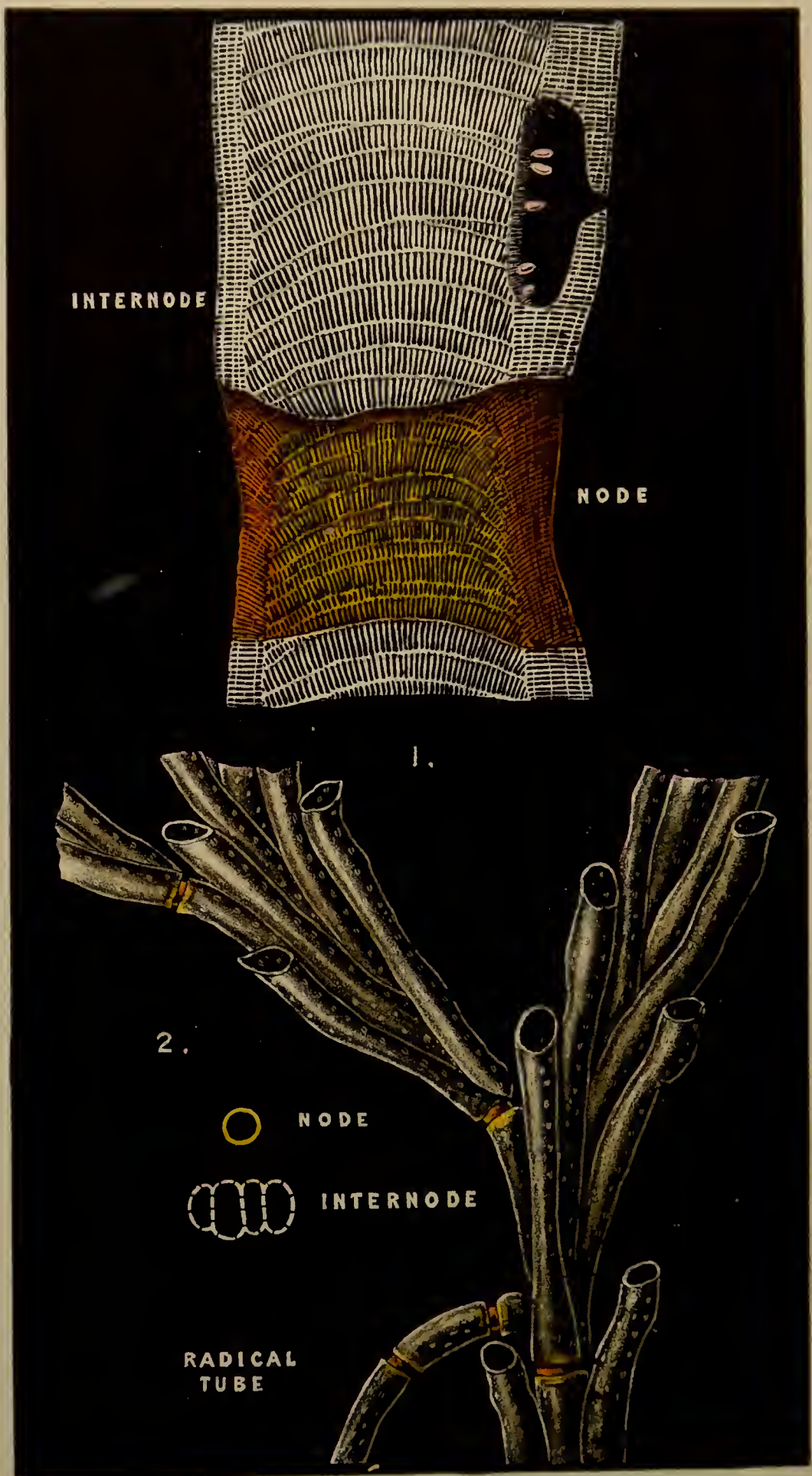
C Stewart del.

1. CYMOPOLIA BARBATA.

Diagramatic sect. $\times 10$.

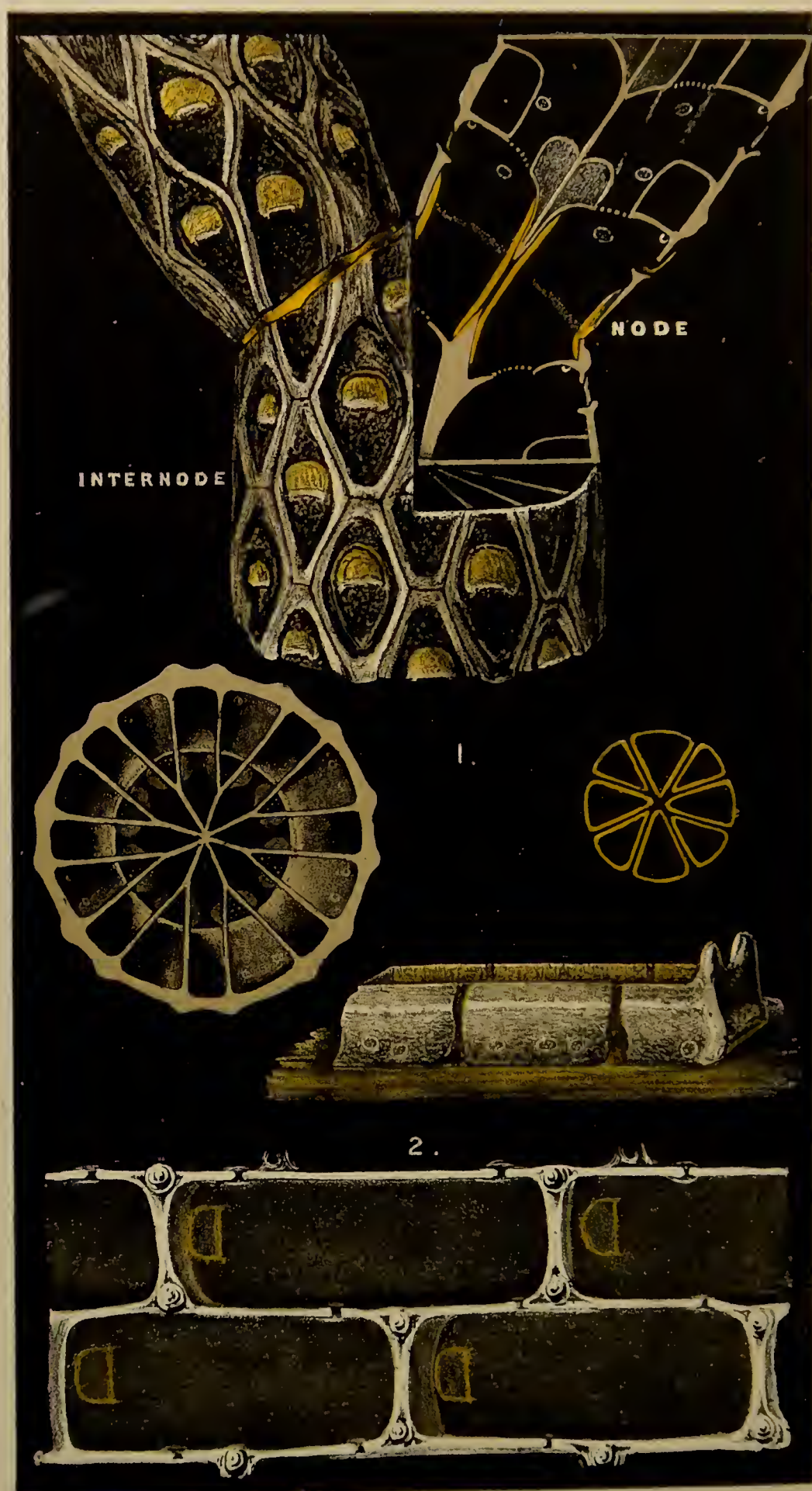
2. HALIMEDA TUNA.

Long. sect. $\times 40$.



C. Stewart del

1. AMPHIROA EPHEDRÆA.
Long. sect. X 50.
 2. CRISIA EBURNEA.
X 50.



C. Stewart del.

1. CELLARIA SINUOSA.

Diagramatic sect. X. 40.

2. MEMBRANIPORA MEMBRANACEA.

X. 50.

calcareous internodes are united by a bundle of about 20 noncalcified tubes forming the node. The calcareous matter is most dense at the external surface of the internode. From the shores of the Mediterranean and West Indies. Pl. IX. fig. 2. *Presented by G. R. M. Murray, Esq.*

- B. 40. A calcareous Alga, one of the Florideæ (*Amphiroa ephedraea*), and drawing of its structure. The flexible nodes consist of noncalcified cells. In the internodes the cell-walls are calcified, stiff and brittle. When fresh or moist the plant readily bends without breaking, but when dry the slightest touch causes fracture. From the Cape of G. Hope and Australia. Pl. X. fig. 1.

Presented by G. R. M. Murray, Esq.

ANIMALS.

- B. 41. Zoarium of a Bryozoan (*Crisia eburnea*), and drawing of its structure. The tubular polyp-chambers (zoœcia) have rigid and brittle calcareous walls. The first zoœcium of each branch has a horny ring within the calcareous walls that are here partly interrupted so as to expose the ring and allow of flexion. This part constitutes the node. The radical tubes by which the animal is attached have many such nodes. Pl. X. fig. 2.
- B. 42. Zoarium of another Bryozoan (*Cellaria sinuosa*), and drawings. The branching is dichotomous. Each branch normally commences by 8 special zoœcia having their interior lined by flexible horny matter. The calcareous walls break at this point, exposing the dark horny material as a flexible bond of union forming the node. These connecting zoœcia are devoid of the polypide present in all the others, they also differ in other respects. Pl. XI. fig. 1.
- B. 43. *Cellaria sinuosa*. Being preserved in spirit the black horny material of the nodes is more distinct, as it can be seen through the calcareous walls of the zoœcia.
- B. 44. Small portion of a Bryozoan (*Membranipora membranacea*) incrusting a Seaweed (*Laminaria saccharina*), with drawing of structure. The seaweed is constantly bending in the

water; if the Membranipora were rigid it would be the subject of frequent fracture; this is prevented by each calcareous lateral wall of the zoëcium having two places where it is membranous and flexible. The dorsal and ventral walls are entirely membranous. Pl. XI. fig. 2.

Nitsche, Zeitschr. wiss. Zool., Bd. xxi. 1871, p. 418.

- B. 45. Second antenna of a Lobster (*Homarus vulgaris*), with drawing of its structure. The proximal segments can alone be moved by muscles. The long and tapering distal part (flagellum) is composed of calcified rings connected by flexible noncalcified cuticle. This structure, that greatly diminishes the risk of fracture, is common to all filamentous antennæ. The filamentous portion of the antenna that is naturally straight has been coiled to show its flexibility.

Joints that allow of voluntary motion.

INVERTEBRATA.

- B. 46. Spines and plates from the test of a Sea-urchin (*Heterocentrotus mammillatus*, fam. Echinometradæ), some in section, with diagrams showing relation of soft parts. The spine articulates by a ball-and-socket joint, the surface of the socket being about half that of the mamelon.
- B. 47. A similar preparation and diagram of *Phyllacanthus imperialis*, fam. Cidaridæ. A pit in the centre of the socket and mamelon gives attachment to a round ligament. This is also present in the Diadematidæ and Echinoidea Irregularia. The middle spine in the preparation is from *P. baculosa*, the dried soft parts are still attached, the round ligament has been painted blue.

Prouho, Arch. Zool. Exp., t. v. 1887, p. 252.

- B. 48. Separated dorsal and ventral valves of a Brachiopod (*Magellania lenticularis*), with the hinge-region of another specimen. Two processes of the ventral valve (one painted blue) are locked in depressions (one painted red) in the dorsal valve. The valves can only be completely separated by fracture. The articulation admits of but slight motion.

- B. 49.** Three of the six joints of the great claw (chela) of a Lobster (*Homarus vulgaris*). The dorsal surface of the ischiopodite and meropodite is flattened, a single fulcrum being formed by the entire length of the dorsal border.

In the joint between the meropodite and carpopodite there are two fulcra, each about 14 mm. long. The outer fulcrum is overlapped by a process of the meropodite. The joint between the carpopodite and propodite has two fulcra: the dorsal one, as in the previous case, is formed by a narrow line of noncalcified cuticle, by which a special calcified process of the carpopodite is attached to the propodite; on the ventral side the fulcrum is formed by thick cuticle not attached to any process. The regions of both fulcra are strengthened by a hollow process of the carpopodite that overlaps the propodite. On the dorsal side the process has a semicircular groove, into which fits a semicircular ridge on the propodite. On the ventral side the ridge is borne by the carpopodite, the groove by the propodite. In each the fulcrum corresponds with the centre of the semicircle. The fulcra have been painted blue.

Presented by Mr. R. Burton.

Langer, Denkschr. d. k. Akad. Wiss. Wien, Bd. xviii. 1860, p. 101.

- B. 50.** The dorsal and ventral portions of the joint between the carpopodite and propodite of the great claw of a Lobster, separated to show the special semicircular articular surfaces, the ridge on the ventral being borne by the carpopodite, on the dorsal by the propodite. This probably increases the strength of the articulation.

VERTEBRATA.

JAW.

- B. 51.** Joint between the right maxillary and mandibular cartilages of a Skate (*Raja batis*). The articular surface of the maxillary cartilage is irregularly rounded, that of the mandibular concave. The upper border of the latter shows a notch through which protrudes a synovial pouch 8 mm in diameter. The synovial membrane has a few small fringes, but is apparently healthy. The cavity of the joint

is filled in all adults by loose lenticular or irregular-shaped bodies. Some are of minute size, but the great majority have a uniform diameter of 2 mm. They consist of mucin, fibrin, and branched cells. Those removed from this joint are shown below; in bulk they measured between 6 and 7 c.c.

- B. 52.** Portion of the skull with the right mandible of a Duck-billed Platypus (*Ornithorhynchus anatinus*). The temporo-maxillary joint has been opened from the front, to show the absence of any interarticular substance between the two joint surfaces. The condyle of the mandible is convex and laterally expanded, the corresponding glenoid cavity being concave from side to side, convex from before backwards. The movements of the jaws are probably very simple in character.

For Mammalian Joints.—Parsons, Jour. of Anat. & Physiol., vol. xxxiv. 1899, p. 41.

- B. 53.** Right half of the skull of a Tasmanian Devil (*Sarcophilus [Dasyurus] ursinus*) showing the temporo-maxillary joint. The glenoid fossa, as in placental Carnivora, is deeply concave from before backwards, with well-marked pre- and post-glenoid processes. The condyle of the mandible is strongly convex and fairly accurately fits the glenoid cavity. There is no interarticular cartilage.

- B. 54.** Part of the skull with the left mandible of an Armadillo (*Dasypus sexcinctus*). The cavity of the temporo-maxillary joint has been exposed from the outer side to show the small size and simple flattened character of the articular surfaces and the entire absence of any interarticular cartilage.

- B. 55.** A section through the temporal bone and condyle of the lower jaw of a Beaver (*Castor fiber*), giving a posterior view of the double articular cavity and intermediate substance; and showing that the capsular ligament between the interarticular substance and glenoid cavity is longer than that between the interarticular substance and condyle

of the lower jaw; both of which, therefore, in extensive motions of the jaw backwards and forwards, must move together upon the temporal bone. O. C. 261.

Hunterian.

- B. 56. The left ramus of the lower jaw, and part of the cranium of a Porpoise (*Phocæna phocæna*). A section has been made through the joint, to show the fibrous connecting-substance *in situ*. O. C. 240 A.

van Beneden, Arch. de Biol., t. iii. 1882, p. 669.

- B. 57. A section of the ligamentous substance that unites the lower jaw to the cranium in the Whale. O. C. 240.

“The articulation of the lower jaw is not by simple contact either single or double, joined by a capsular ligament, as in the quadruped; but by a very thick intermediate substance of the ligamentous kind, so interwoven that its parts move on each other, in the interstices of which is an oil. This thick matted substance may answer the same purpose as the double joint in the quadruped.”

—*Hunter, Phil. Trans.* 1787, vol. lxvii. p. 384.

Hunterian.

- B. 58. Half of the fibro-cartilaginous mass that formed the squamoso-mandibular articulation of a young female *Balænoptera acuto-rostrata*. O. C. 240 B.

Perrin, Proc. Zool. Soc. 1870, p. 805.

- B. 59. The interarticular ligamentous substance from the joint of the lower jaw of the Elephant (*Elephas indicus*). The surface adapted to the temporal bone is concave in the lesser and convex in the larger diameter; the opposite or lower surface presents a deep, oval excavation for the reception of the condyle of the jaw. O. C. 262.

Hunterian.

- B. 60. A vertical section of the interarticular substance from the joint of the lower jaw of a younger Elephant, showing the degree of concavity on each side, so well calculated for adapting two convex surfaces to each other. A bristle is placed in an orifice leading out of the lower cavity. O. C. 263.

Hunterian.

- B. 61.** The counterpart of the preceding preparation, divided horizontally, and exhibiting a disposition of the outer ligamentous fibres in concentric circles, similar to the intervertebral substances of the spine. O. C. 264. *Hunterian.*
- B. 62.** Right temporo-maxillary joint of a Horse (*Equus caballus*). The joint-cavity has been opened from behind to show the slightly curved character of the articular surfaces and the thin plate of fibro-cartilage intersposed between them. The cartilage assists in adapting the articular surfaces to one another during the complicated rotary and gliding movements of which the jaw is capable.
Chauveau & Fleming, 'Anatomy of the Domestic Animals,' 1873, p. 138.
- B. 63.** A similar preparation of the left temporo-maxillary joint of a Sheep (*Ovis aries*). The surfaces of articulation are more flattened than in the Horse, and eminently adapted for gliding movements. Two slips from the masseter are attached to the antero-lateral surface of the capsule; one near its upper border, the other where it is attached to the interarticular substance.
- B. 64.** A vertical and longitudinal section of part of the lower jaw and temporal bone of a young Lion (*Felis leo*), exhibiting the interarticular substance extending through the whole of the joint, and dividing it into two synovial cavities. O. C. 258. *Hunterian.*
- B. 65.** The corresponding section of the same parts, showing the similar conditions. O. C. 259. *Hunterian.*
- B. 66.** A vertical and transverse section of part of the lower jaw and temporal bone of a Lion, showing the extent of the joint in that direction and the form of the interarticular substance, convex from side to side above, concave below. O. C. 260. *Hunterian.*
- B. 67.** A vertical section of part of the temporal bone and ramus of the lower jaw of a Human subject, exhibiting the forms

of the glenoid and condyloid articular cavities, and of the intermediate fibrous cartilage. O. C. 265.

“Just under the beginning of the zygomatic process of each temporal bone, before the external meatus auditorius, an oblong cavity may be observed; in direction, length, and breadth, in some measure corresponding with the condyle of the lower jaw. Before, and adjoining to, this cavity, there is an oblong eminence placed in the same direction, convex upon the top in the direction of its shorter axis, which runs from behind forwards; and a little concave in the direction of its longer axis, which runs from within outwards. It is a little broader at its outer extremity, as the outer corresponding end of the condyle describes a larger circle in its motion than the inner. The surface of the cavity and eminence is covered with one continued smooth cartilaginous crust, which is somewhat ligamentous, for by putrefaction it peels off, like a membrane, with the common periosteum. Both the cavity and eminence serve for the motion of the condyle of the lower jaw. The surface of the cavity is directed downward; that of the eminence downward and backward, in such a manner, that a transverse section of both would represent the italic letter *f*. Though the eminence may, on a first view of it, appear to project considerably below the cavity, yet a line drawn from the bottom of the cavity to the most depending part of the eminence is almost horizontal, and therefore nearly parallel with the line made by the grinding surfaces of the teeth in the upper jaw; and when we consider the articulation farther, we shall find that these two lines are so nearly parallel, that the condyle moves almost directly forwards in passing from the cavity to the eminence; and the parallelism of the motion is also preserved by the shape of an intermediate cartilage.

“In this joint there is a moveable cartilage, which, though common to both condyle and cavity, ought to be considered rather as an appendage of the former than of the latter, being more closely connected with it, so as to accompany it in its motion along the common surface of both the cavity and eminence. This cartilage is nearly of the same dimensions with the condyle, which it covers; is hollowed on its inferior surface to receive the condyle: on its upper surface it is more unequal, being moulded to the cavity and eminence of the articulating surface of the temporal bone, though it is considerably less, and is therefore capable of being moved with the condyle from one part of that surface to another. Its

texture is ligamento-cartilaginous. This moveable cartilage is connected with both the condyle of the jaw and the articulating surface of the temporal bone, by distinct ligaments, arising from its edges all round. That by which it is attached to the temporal bone is the most free and loose; though both ligaments will allow an easy motion, or sliding of the cartilage on the respective surfaces of the condyle and temporal bone. These attachments of the cartilage are strengthened, and the whole articulation secured, by an external ligament which is common to both, and which is fixed to the temporal bone and to the neck of the condyle. On the inner surface of the ligament which attaches the cartilage to the temporal bone, and backwards, in the cavity, is placed what is commonly called the gland of the joint; at least, the ligament is there much more vascular than at any other part."—*Hunter, On the Teeth*, 4to, 1st edit., 1771, p. 9.

Hunterian.

VERTEBRAL COLUMN.

ACENTROUS.

Gadow & Abbott, *Phil. Trans.*, vol. clxxxvi. 1895, p. 163,
& Gadow, vol. clxxxvii. 1896, p. 1.

- B. 68.** Three portions of the notochord of a Sea-Lamprey (*Petromyzon marinus*), showing a series of cartilaginous dorsal arches lying in the lateral walls of the mass of connective tissue that surrounds the neural canal.

In the anterior region of the body (middle specimen) the arches are irregular in shape, but further back, in the region of the liver (lower specimen), they are more regular.

The upper specimen is a transverse section through the anterior region and shows the relation of the arches to the neural canal.

Schneider, 'Beiträge zur vergleichenden Anatomie und Entwicklungsgeschichte der Wirbelthiere,' Berlin, 1879, p. 51.

- B. 69.** Portion of vertebral column, and head of a Sea-Lamprey (*Petromyzon marinus*). The ventral portion of the notochord and cartilaginous cranium has been removed in front

to show the pointed extremity of the notochord surrounded by the cranial cartilage. O. C. 230 c.

B. 70. Anterior portion of a Glutinous Hag (*Myxine glutinosa*), showing the notochord. O. C. 230. *Hunterian*.

B. 71. Portions of the vertebral column of a Sea-Cat (*Chimæra monstrosa*). The column, although without any suggestion of vertebral bodies, is potentially chorda-centrous owing to the invasion of the chordal sheath by cells from the skeletogenous layer. The continuous notochord is surrounded by a delicate elastica externa and a very thick elastica interna (chordal sheath). The latter is to a considerable extent cartilaginous, and is divided into an inner and outer layer by a series of narrow calcified rings, contiguous with one another and far more numerous than the basi-dorsalia. The dorsal arches are composed of basi-dorsalia, inter-dorsalia, and supra-dorsalia; towards the middle of the body the supra-dorsalia disappear, and in the tail-region they are followed by the inter-dorsalia. The ventralia consist of a double row of small irregular cartilages. A certain number of the anterior arcualia are fused together and enlarged to provide a support for the anterior spine of the dorsal fin. The skull articulates to the vertebral column by a diarthrodial joint.

The upper specimen is the anterior portion of the vertebral column, in it some of the dorsalia are outlined in black. The next specimen (part in sagittal section) is taken from the middle of the body; beneath is a transverse section from the same region. The two lower specimens are from the tail.

Hasse, 'Natürliches System der Elasmobranchier,' Jena, 1882, p. 25.

B. 72. Specimens of the calcareous rings from the chordal sheath of a Sea-Cat (*Chimæra mediterranea*). The rings have the form of narrow fibrous bands, with a deep concavity running round their outer side. They are composed of dense calcified connective tissue, the fibres and cells of which are packed closely together with their long axes mainly parallel

to the circumference of the ring. Two isolated rings are mounted above, and below are two pieces (one in section) composed of several contiguous rings.

Hasse, 'Natürliches System der Elasmobranchier,' Jena, 1882, p. 33.

- B. 73. Transverse sections of the spine of the Southern Chimæra (*Callorhynchus australis*), in which the notochord is persistent, but has a thicker fibrous sheath, in which there is no trace of calcification: the vertebræ are indicated by the small cartilaginous dorsalia and ventralia. O. C. 236 A.

Hasse, Nat. Syst. Elasmobranchier, 1882, p. 30.

- B. 74. A portion of the notochord of a Sturgeon. A longitudinal section has been made on one side, which exposes some small cavities in the centre. O. C. 232. *Hunterian*.

- B. 75. A longitudinal section of the notochord and sheath of a Sturgeon, showing the thickness of the sheath, and exposing a larger central cavity in the notochord. O. C. 233.

Hunterian.

- B. 76. A transverse section of the spine of a Sturgeon (*Acipenser sturio*). It shows the persistent continuous notochord: the inner layer of the fibrous sheath of the notochord has increased in thickness. In the skeletogenous tissue are developed distinct, firm, and opaque cartilages—the dorsalia, which consist of two superimposed pieces on each side, the basal portion bounding the neural canal, the apical portion a superior canal, filled by fibrous elastic ligament and adipose tissue: above this is the single cartilaginous supradorsal. The ventralia are now distinctly developed, and joined together by a continuous expanded base, forming an inverted arch beneath the notochord, for the vascular trunks. O. C. 234.

Hunterian.

- B. 77. A longitudinal section of the anterior part of the spine of a Sturgeon, which shows the gradual contraction of the notochord as it approaches the head. The whole spine

being composed of very elastic materials, renders the existence of joints and vertebral bodies unnecessary. O. C. 235. *Hunterian.*

v. Ebner, Sitz. d. k. Akad. Wiss. Wien, Bd. civ. Hft. 3, 1895, p. 149.

CHORDACENTROUS.

- B. 78.** Portions of the precaudal cartilaginous vertebral column of a Greenland Shark (*Læmargus borealis*), part in section. Each vertebra consists of cartilage only. A disc having a thickness at its centre of 4 mm., increased to 10 mm. at the lateral margins, and dorsally enlarging so as to come in contact with those of neighbouring vertebræ, but ventrally separated by prolongations of the interventralia, represents the centrum. It is formed in the sheath of the notochord (=chorda-central type). Continuous with the dorsal surface of the centrum are a pair of basidorsalia that commence by a broad base. The intervals between the basidorsalia are filled by the interdorsalia. Lateral processes, the basi-ventralia and interventralia, largely repeat the features of the dorsalia. The pairs of dorsalia and ventralia both fuse in the mid line. The notochord is largely persistent.

Hasse, Nat. Syst. Elasmobranchier, 1882, p. 55.

- B. 79.** Portions of the vertebral column of the same fish from the junction of the caudal and precaudal regions. There is no trace of calcification. Red glass rods indicate some of the openings for the roots of the spinal nerves.

- B. 80.** Portions of the vertebral column of a Fox Shark (*Alopias vulpes*) taken from the precaudal region.

In the lower specimen the anterior vertebræ are in sagittal section; the posterior vertebræ show the superficial striations upon the centra due to the edges of a series of radiating calcified plates, the relative size and position of the arcual cartilages is also shown.

The upper specimen is a transverse section through the middle of a centrum, and shows the radiating calcified plates and the relations of the bases of the arches to the centrum.

B. 81. Portion of the vertebral column of a Fox Shark (*Alopias vulpes*) from the caudal region, showing especially the dorsalia and interdorsalia; also ventralia and interventralia.

B. 82. Portion of the vertebral column (part in section) of a Porbeagle Shark (*Lamna cornubica*) showing a flattened continuous band of yellow elastic tissue closely adherent to its cartilaginous spinous processes. The biconcave (amphicoelous) vertebral bodies are well developed. Their cartilage is calcified on their articular surfaces, and around the sheath of the notochord, from which point four sets of calcareous plates extend to the circumference, their intervals being occupied by cartilage. The cartilaginous neural arches (dorsalia and interdorsalia) show the openings for the dorsal and ventral roots of the spinal nerves, into the former green and into the latter red glass rods have been introduced. On either side of the ventral surface of the column are cartilaginous plates, the ventralia and interventralia.

Hasse, Nat. Syst. Elasmobranchier, 1882, p. 214.

B. 83. Transverse section of the vertebral column of a young Basking Shark (*Selache maxima*) that measured twelve feet in length. The notochord is continuous, enlarging at intervals to form the soft intervertebral discs. Concentric rings of calcification traverse the cartilaginous body. These rings are interrupted by the cartilaginous continuations of the neural arches (dorsalia) and transverse processes (ventralia). The concentric plates are in later life followed by radiating ones. O. C. 237 B a.

Hasse, Nat. Syst. Elasmobranchier, 1882, p. 236.

B. 84. Transverse section of half a vertebra of an older example of a Basking Shark (*S. maxima*) showing the radiating plates of calcified cartilage that invest the concentric ones. There are also fine radiating lines of calcification between the concentric plates.

B. 85. Terminal caudal vertebræ of a Piked Dog-fish (*Acanthias vulgaris*) showing besides the vertebræ, the horny filaments that support the extreme edge of the fin-membrane.

O. C. 279 D.

Presented by W. Clift, Esq.

Hasse, Nat. Syst. Elasmobranchier, 1882, p. 93.

- B. 86.** Portion of the precaudal vertebral column including six vertebræ of a Skate (*Raja batis*). O. C. 237 D.
- B. 87.** Three portions of the vertebral column of a Ray (*Raja clavata*) taken respectively from the anterior, median, and posterior regions of the body. The column is formed in its anterior part (upper specimen) of a single rigid mass of cartilage, in which the only indication of segmentation is afforded by the nerve-foramina (31 pairs) on each side. The characters of this part of the column have probably arisen in response to the demand for additional strength to support the enlarged pectoral fins. Somewhat posterior to the shoulder-girdle, the segmented notochord appears; its upper and lateral surfaces are enveloped by basi- inter- and supra-dorsalia and basiventralia (the latter are at first continuous with the basidorsalia). In the middle specimen the transition from trunk to tail is shown; the basiventralia become separated from the basidorsalia, migrate to the ventral aspect of the notochord and there, with the addition of inter-ventralia, form the hæmal arches. The interdorsalia are gradually suppressed. The lower specimen shows the degenerate condition of the tail.

Hasse, Nat. Syst. Elasmobr. 1882, p. 168.

ARCHCENTROUS.

- B. 88.** Portions of the vertebral column of *Lepidosteus osseus*. The vertebral bodies are opisthocœlous and developed entirely from the arches without invasion of the chordal sheath by skeletogenous cells (archcentra). In the adult the notochord is altogether suppressed. The three upper specimens are taken from the precaudal region, the two lower from the caudal.

Balfour & Parker, Phil. Trans., vol. clxxii. 1882, p. 386.

- B. 89.** Portions of the trunk region of the vertebral column of a Cod (*Gadus morrhua*).

Each vertebral body consists of a deeply biconcave disc of bone, smooth and hard upon its concave surface, but of looser texture outside. It is attached to the bodies of neighbouring vertebræ by the edges of its cavities by means

of fibrous tissue. The biconical space enclosed between each pair of vertebral bodies is filled with a gelatinous material that represents the remains of the notochord.

The articulation of the bodies with each other is rendered more rigid by an overlapping of processes on the bodies by corresponding projections of the neural arch and transverse processes of the succeeding vertebra.

An anterior view of a vertebra is shown above ; below, 11 vertebræ (the first 5 of which are in sagittal section) are seen from the left side.

Scheel, *Morph. Jahrb.*, Bd. xx. 1893, p. 1.

- B. 90.** The caudal extremity of the vertebral column of *Lepidosiren paradoxa* seen from the left side. In this and in the other Dipnoi the notochord is obliterated towards the end of the tail and replaced by a number of rectangular blocks of cartilage, each surmounted by a variable number of arcualia. They probably do not represent vertebral bodies.

Klaatsch, *Morph. Jahrb.*, Bd. xx. 1893, p. 151.

- B. 91.** A longitudinal and vertical section of two vertebræ of a Siren (*Siren lacertina*). The articular surfaces of the bodies of the vertebræ are hollowed out as in fish, but the cavities are occupied by ligamentous fibres disposed in concentric circles : the articular processes are joined by capsular and synovial membranes. O. C. 246.

Hunterian.

Mivart, *Proc. Zool. Soc.* 1870, p. 260.

- B. 92.** A longitudinal and vertical section of the cervical vertebræ of a Turtle (*Chelone mydas*), the bodies of which are connected by ligamentous substance passing between the whole of their articular surfaces.

These surfaces, in the first, second, and third vertebræ, are convex at the anterior part, and concave at the posterior; in the fourth they are convex at both ends; the anterior surface of the fifth is concave, the posterior plane; both surfaces are plane in the sixth; but the posterior surface of the seventh vertebra is convex. O. C. 248. *Hunterian.*

B. 93. Eight dorsal vertebræ of Monitor Lizard (*Varanus salvator*). A sagittal section has been made of the anterior vertebræ, it shows the joint cavities between the procœlous vertebral bodies. The articulations of the ribs are seen on the posterior vertebræ.

B. 94. Vertebræ of *V. salvator* in horizontal longitudinal section, showing the procœlous intervertebral joints.

B. 95. Vertebræ with portions of ribs attached of Boa constrictor (*Python sebae*). A strong common ligament extends along the ventral faces of the bodies. The capsular ligament of the ribs is most strongly developed dorsally and ventrally, anteriorly the joint-cavity is bounded by a plate of yellow elastic fibrous tissue.

Rochebrune, Jour. de l'Anat. et Physiol., t. xvii. 1881, p. 185.

B. 96. A longitudinal and transverse section of the bodies of the vertebræ of a large Serpent (*Python tigris*), exhibiting the forms of their articular surfaces, O. C. 250 c.

B. 97. Left half of a portion of the vertebral column of a Boa (*Python tigris*), the ribs being left attached. O. C. 250 B.

B. 98. Two cervical vertebræ and one dorsal of a Crocodile (*C. acutus*) showing, in end view, the structure of the intervertebral joint.

Between each pair of centra there is a fibro-cartilaginous intervertebral disc, that, owing to the procœlous character of the joint, has the form of an obtuse hollow cone.

Along the outer margin of the disc there is a strong fibrous band united superficially to the outer ligament but free towards the disc, except at a point on either side. This disc is the homologue of an intercentrum (basi-ventrals).

A blue rod has been inserted in each specimen between the fibrous band and the disc.

Gegenbaur, Jena. Zeitschr., Bd. iii. 1867, p. 400.

B. 99. Two dorsal vertebræ of a Crocodile (*C. acutus*) from which the spines and dorsal arches have been removed to

show the intervertebral fibrous band. A green rod and black bristles have been inserted in different places between it and the intervertebral disc.

- B. 100.** A longitudinal horizontal section of two cervical vertebræ of an Ostrich (*Struthio camelus*), exposing the cavity of the joint which unites these vertebræ; here, the anterior surface is convex, the posterior concave. O. C. 251.

Hunterian.

- B. 101.** A longitudinal vertical section of two anterior dorsal vertebræ of the Ostrich, the bodies of which are articulated by a capsular ligament, as in the preceding specimen; the articular surfaces are saddle-shaped, with the two faces in reversed positions. The canal for the passage of the medulla spinalis is enlarged near the articulation, to prevent its being compressed in the motions of that part of the spine. O. C. 252.

Hunterian.

- B. 102.** Vertebra of *Tachyglossus* [*Echidna*] *aculeata*, and left halves of two others, showing the intervertebral substance, and its central cavity. O. C. 246 A.

- B. 103.** A transverse section of the intervertebral substance of the Bottlenose Whale (*Hyperoodon rostrata*).

It is 153 mm. in diameter; the external 13 mm. appears of uniform consistency, and exhibits very little of the fibrous character. The rest of the substance, to within 16 mm. of the centre, is composed of ligamentous fibres arranged in concentric circles, and at nearly equal distances; the remaining central part appears to be wholly occupied by glairy matter. O. C. 245.

Hunterian.

Hunter, On the Whale, Phil. Trans., vol. lxxvii. 1781, tab. xix.

- B. 104.** A longitudinal section of two caudal vertebræ of a Horse (*Equus caballus*). These vertebræ form a remarkable contrast to those of fishes, as they present to each other convex, instead of concave, surfaces. O. C. 242.

Hunterian.

B. 105. A single vertebra from the tail of a Horse, exhibiting a transverse section of the intervertebral substance, the ligamentous fibres of which are disposed in concentric circles, which recede from each other as they approach the centre, and have a glairy fluid in the interspaces. O. C. 243.
Hunterian.

B. 106. Atlas vertebra of a Seal (*Phoca vitulina*). A stout wedge-shaped ligamentous band is attached to the antero-ventral surface of the vertebral body. It lies dorsal to the anterior occipito-atlantal ligament with its narrow free border directed forwards, and fills up the hollow between the two occipital facets. The odontoid process is embraced between this ligament and the transverse ligament of the atlas.

RIBS.

B. 107. A dorsal vertebra, and the vertebral extremity of a rib of an Ostrich, showing that the latter is articulated by distinct capsular ligaments to two different parts of the vertebra; viz., the parapophysis below, and the diapophysis above. The orifice for the admission of air into the rib may be observed in the angle of the neck and tubercle. O. C. 253.
Hunterian.

B. 108. A portion of the sternum and the sternal extremity of the rib of an Ostrich, showing that this part is also articulated by distinct capsules to two points of the sternum. The sternal and vertebral portions of the rib are also articulated by a synovial capsule. O. C. 254.
Hunterian.

B. 109. Some dorsal vertebræ with portions of ribs attached from the Duck-billed Platypus (*Ornithorhynchus anatinus*). A transverse ligament unites the heads of the ribs, it lies on the ventral surface of the intervertebral disc.

B. 110. Bodies of the 3rd to the 11th dorsal vertebræ of a Mole (*Talpa europæa*) with the heads of the corresponding ribs. A black bristle has been placed beneath the transverse ligaments; these lie on the dorsal surface of the intervertebral disc, and each is attached to the heads of a pair of ribs.

Sutton, Jour. Anat. & Phys., vol. xviii. 1884, p. 225.

B. 111. The 2nd to the 9th dorsal vertebræ of a Fox-Squirrel (*Sciurus ludovicianus*), with the articular extremities of the corresponding ribs. The dorsal arches have been removed to show a transverse ligament passing between each pair of ribs, from head to head, on the dorsal surface of the intervertebral disc. The ligaments (behind which a black bristle has been placed) are only present between the heads of the third to the ninth pairs of ribs.

B. 112. A dorsal vertebra, and the articular extremities of four ribs of a Horse (*Equus caballus*).

These are attached by capsular ligaments to the angles of the body of the vertebra; they have also a strong transverse ligament which passes from the head of one rib, dorsally to the intervertebral substance, to the head of the opposite rib; thus connecting them firmly to each other, and to the vertebra. O. C. 257. *Hunterian.*

B. 113. Centrum of a dorsal vertebra of a Tapir (*Tapirus terrestris*) with the heads of the corresponding pair of ribs, showing a similar transverse ligament.

B. 114. Portions of four dorsal vertebræ of Sheep (*Ovis aries*) with extremities of ribs attached, showing the strong transverse ligament that unites the heads of the ribs.

Presented by P. D. Coghill, Esq.

B. 115. One mid-dorsal, and two last dorsal vertebræ, also articular ends of ribs, showing transverse ligament uniting their heads. From a Seal (*Phoca vitulina*), seven days old.

The ligaments proper to each pair of ribs are two in number, they traverse respectively the dorsal and ventral surfaces of the intervertebral disc.

Presented by the Zoological Society.

B. 116. The 7th to 11th dorsal vertebræ of a Dog (*Canis familiaris*), with the heads of the corresponding ribs attached. The neural arches have been removed to show four stout transverse ligaments. They are only present between the heads of the seventh to the tenth pairs of ribs.

- B. 117. Tenth to thirteenth dorsal vertebræ of a Chimpanzee (*Anthropopithecus troglodytes*), showing ribs attached to all the transverse processes.

SHOULDER-GIRDLE.

- B. 118. Right scapula and clavicle of a Tasmanian Devil (*Sarcophilus* [*Dasyurus*] *ursinus*). The clavicle is attached by ligament to both the coracoid and acromion processes of the scapula.
- B. 119. Anterior part of the sternum with the clavicles of an Armadillo (*Dasypus sexcinctus*), showing the sterno-clavicular articulation. Each clavicle is attached to one of the two anterior processes of the expanded manubrium sterni by a ligament in which are embedded two nodules of cartilage. Owing to the position of the sternal end of the clavicle directly dorsal to the manubrial process, the ligament undergoes a ventral twist in passing from one to the other.
Hoffmann, Niederl. Arch. f. Zool., t. v. 1879-82, p. 66.
- B. 120. Left scapula and clavicle with the distal ends of the first two ribs of Three-toed Sloth (*Bradypus tridactylus*). The clavicle is rudimentary and represented only by a nodule of bone imbedded in a ligament that passes between the sternal extremity of the first rib and the coracoid.
Humphry, Jour. Anat. & Physiol., vol. iv. 1870, p. 26.

SHOULDER.

- B. 121. The right anterior extremity of a Bull-Frog (*Rana catesbiana*).

The shoulder-joint is laid open, and the capsule turned back, to show an interarticular ligament passing from a depression in the head of the humerus to a depression in the centre of the glenoid cavity, and attached also to the inferior margin of that cavity. A bristle is passed behind this ligament: a small synovial bag projects into this joint just above the insertion of the ligament.

This additional security against dislocation of the shoulder-joint appears to be necessary in the frog, to obviate the

effects of the shock, or impulse, which the anterior extremities receive when the animal alights from a leap. O. C. 255 K.

- B. 122.** Right shoulder-joint of a Duck-billed Platypus (*Ornithorhynchus anatinus*). The glenoid cavity has the form of a groove with open ends, deeply concave in a dorso-ventral direction, but slightly convex transversely. The head of the humerus is laterally expanded and constitutes a roller-shaped condyle of slightly crescentic form; the hollow of the crescent fits against the lower (coracoid) lip of the glenoid groove and is connected to it by a stout gleno-humeral ligament. The form of the articular surfaces and looseness of the capsule except where it forms the gleno-humeral ligament allow of considerable rotation of the humerus.

Attached to the apex of the internal tuberosity there is a small loose nodule of bone on which the subscapularis muscle is inserted. This bone has been compared to the os humero-scapulare of the bird.

- B. 123.** Right shoulder-joint of an Opossum (*Didelphys marsupialis*). The capsule has been opened to expose a stout gleno-humeral ligament, which arises from the glenoid border beneath the biceps tendon, passes diagonally across the joint-cavity free of the capsule, and is attached to the inner side of the head of the humerus. The gleno-humeral ligament in this and the following specimens is apparently the middle gleno-humeral ligament of human anatomy.
- B. 124.** Left shoulder-joint of a Tasmanian Devil (*Sarcophilus [Dasyurus] ursinus*) showing a similar gleno-humeral ligament.
- B. 125.** Left shoulder of a Six-banded Armadillo (*Dasypus sexcinctus*). A blue glass rod has been placed beneath the gleno-humeral ligament that is free in the joint-cavity. A green glass has been passed beneath a special thickening of the external wall of the capsule.
- B. 126.** Right shoulder-joint of Nine-banded Armadillo (*Tatusia novemcincta*). A bristle has been passed below the free gleno-humeral ligament

- B. 127. Right shoulder-joint of a Hedgehog (*Erinaceus europæus*).
A black bristle has been placed below the delicate gleno-humeral ligament.
- B. 128. Right shoulder-joint of a Rabbit (*Lepus cuniculus*),
showing the free gleno-humeral ligament.
- B. 129. Right shoulder-joint of Guinea-pig (*Cavia porcellus*),
showing gleno-humeral ligament.
Presented by F. S. Eve, Esq.
- B. 130. Right shoulder-joint of Capybara (*Hydrochærus capybara*), showing a gleno-humeral ligament.
- B. 131. Right shoulder-joint of Coypu (*Myocastor coypus*),
showing a gleno-humeral ligament.
- B. 132. Left shoulder-joint of a Beaver (*Castor canadensis*),
showing a gleno-humeral ligament.
Presented by J. B. Sutton, Esq.
- B. 133. Left glenoid cavity of foetal Elephant (*Elephas indicus*).
A fold of the capsule is situated near the dorsal border of the glenoid cavity. The glenoid ligament may be seen beneath the coracoid process.
- B. 134. Right shoulder-joint of a Dog (*Canis familiaris*), showing
a gleno-humeral ligament.
- B. 135. Left shoulder-joint of *Colobus vellerosus*, showing a fold
of capsule representing the gleno-humeral ligament.
- B. 136. Right shoulder-joint of Orang-Outang (*Simia satyrus*),
showing a fold of the capsule representing the gleno-humeral ligament.
Presented by Victor Horsley, Esq.
- B. 137. Left shoulder-joint of Orang-Outang (*Simia satyrus*),
showing a gleno-humeral ligament.
- B. 138. The parts constituting the left Human shoulder-joint.
The capsular ligament is laid open to expose the head of the humerus, and the tendon of the long head of the biceps

muscle passing along the upper part of the articular cavity, and attached to the marginal ligament of the glenoid cavity of the scapula. The section of the capsular ligament shows its relative thickness at the upper and lower part. O. C. 255. *Hunterian.*

ELBOW.

- B. 139.** Right elbow of a Frog (*Rana clamata*) in which the articular surfaces have been exposed. The bone formed by the fusion of radius and ulna articulates by a simple concave facet with the single hemispherical condyle of the humerus. The internal epicondyle is prominent, and bears on its median surface a facet, which engages with a corresponding facet on the inner surface of the ulna head. The form of the articular surfaces indicates a very considerable freedom of movement in all directions except towards the inner side, where it is checked by the epicondylo-ulnar articulation.

Cuénod, Internat. Jour. Anat. & Physiol., vol. v. 1888, p. 390.

- B. 140.** Right elbow-joint of a Turtle (*Chelone mydas*). The articular surface on the humerus for the radius is rounded and smaller than that for the ulna. A fold of the capsule projects from behind.

Presented by George Ring, Esq.

- B. 141.** Right elbow-joint of a Goose (*Anser domesticus*) opened from the flexor aspect to show the form of the joint surfaces. The curvatures of the two humeral condyles are eccentric to the axis of rotation of the joint in different directions, so that in extension the radius is drawn towards the shoulder and the ulna protruded—in flexion the reverse. The horizontal gliding of the radius upon the ulna is assisted by the presence of articular facets where the two bones touch, and by a band of fibro-cartilage (indicated by a black bristle) stretched between the dorsal borders of their heads. By this movement of the radius, the hand, upon extension of the elbow, is automatically brought into line with the

forearm. The flexor surface of the capsule is greatly strengthened by more or less independent ligaments.

Garrod, Proc. Zool. Soc. 1875, p. 82.

- B. 142.** Left elbow-joint of Duck-billed Platypus (*Ornithorhynchus anatinus*). The humerus has been displaced to show the form of the joint surfaces. The ulna lies directly behind the radius, and their combined articular surfaces form a simple concavity which plays upon a corresponding single convex facet on the humerus. The joint forms a perfect hinge.

Tornier, Morph. Jahrb., Bd. xii. 1887, p. 407.

- B. 143.** Right elbow-joint of a Koala (*Phascolarctus cinereus*), showing the form of the articular surfaces. The ulna lies slightly to the inner side of the radius ; its articular surface is composed of two distinct parts—one of which, as in the Monotremes, forms a simple concavity with that of the radius and articulates with a single convex facet on the humerus ; the other has the appearance of a lateral excrescence upon the inner side of the first and articulates with a separate convexity on the head of the humerus.

- B. 144.** A vertical section of the articular extremities of the Human humerus and ulna, showing the trochlea of the former bone to which the articular cavity of the latter is adapted, and the mode in which the power of the triceps brachii is increased by the projection of the olecranon, its point of insertion, beyond the centre of motion. O. C. 273.

Hunterian.

- B. 145.** Elbow-joint of Man dissected to show the form and position of the orbicular ligament.

The ligament is a strong fibrous band attached to the anterior and posterior margins of the lesser sigmoid cavity ; it encircles the head of the radius and is attached, proximally to the capsular ligament, distally by a loose thin membrane to the neck of the radius. It assists in pronation and supination by allowing the radius to freely rotate upon its own axis.

Cathcart, Jour. Anat. & Physiol., vol. xix. 1885, p. 355.

WRIST.

- B. 146.** Right wrist-joint of a Duck-billed Platypus (*Ornithorhynchus anatinus*). The scaphoid and lunar are fused to form a single bone articulating with the radius and to a slight extent with the ulna. Two large lateral prominences on its proximal surface engage with corresponding depressions upon the radius and ulna, while the groove between them is occupied by a process of the radius. This interlocking between the proximal row of carpals and the bones of the fore-arm restricts the movements of the wrist to simple flexion and extension.
- B. 147.** Left wrist-joint of a Spider Monkey (*Ateles melanochir*). An interarticular fibro-cartilage (triangular cartilage) is inserted between radius and ulna in the distal radio-ulnar joint. The articulation between the ulna and the cuneiform bone is separated by an antero-posterior septum from that between the radius and the scaphoid and semilunar.
- B. 148.** Left wrist-joint of *Papio* [*Cynocephalus*] *sphinx*. The posterior radio-carpal ligament consists of two fasciculi, that converge from their separate origin on the radius to a common insertion on the cuneiform. The styloid process of the ulna is prominent and articulates with the cuneiform and pisiform bones. There is a partial septum between the two halves of the joint. *Presented by Prof. F. G. Parsons.*
- B. 149.** A dissection showing the fibro-cartilage at the radio-ulnar articulation of the left side of a Man. O. C. 268 A.
 Corner, Jour. Anat. & Physiol., vol. xxxii. 1898, p. 272.

DIGITS.

- B. 150.** A vertical section of the fore-foot of a Horse (*Equus caballus*).
 In this are illustrated all the contrivances for augmenting the moving powers, and diffusing the concentrated forces of pressure and percussion.
 The interphalangeal joints are imperfect hinges, that allow of slight lateral movements in addition to those of

flexion and extension. The posterior ligament of the 1st interphalangeal joint is of great power to withstand the tendency to overextension due to the weight of the body : it is united laterally to the tendon of the flexor sublimis and extends up the posterior surface of the 1st phalanx to become confounded with the sesamoid ligaments of the metacarpophalangeal joint. O. C. 279.

PELVIC GIRDLE.

- B. 151.** A section of the sacrum and pelvic girdle of a Man. The dorsal portion of the sacro-iliac articulation is firmly united by fibrous tissue, the ventral shows a distinct synovial cavity.

HIP.

- B. 152.** The os innominatum and femur of a large Tortoise (*Testudo indica*).

The hip-joint is laid open to show that the ligamentum teres is absent. This simple form of joint obtains at the hip in all Chelonian reptiles. O. C. 255 A.

Presented by W. Clift, Esq.

- B. 153.** The right os innominatum, os marsupiale, and femur of a Duck-billed Platypus (*Ornithorhynchus anatinus*).

The anterior part of the capsule of the hip-joint has been removed to expose the head of the thigh-bone, and the cotyloid cavity, and to show that the ligamentum teres is absent in this species.

- B. 154.** The left os innominatum, os marsupiale, and femur of *Echidna aculeata*.

The head of the femur is turned out of the cotyloid cavity, to show the absence of the ligamentum teres. There is a foramen at the back part of the cotyloid cavity, which is deficient at that part, as it is in birds. O. C. 255 B.

- B. 155.** Left hip-joint of a Koala (*Phascolarctus cinereus*).

The joint has been opened to show the ligamentum teres,

extending from the transverse ligament to the articular cartilage of the head of the femur.

(No depression can be seen on the head of the femur in the dried bone.)

B. 156. The right os innominatum and femur of the Two-toed Sloth (*Cholæpus didactylus*). The hip-joint is laid open to show absence of the ligamentum teres. O. C. 255 H.

B. 157. Upper part of the femur of a Two-toed Sloth (*Cholæpus didactylus*). There is no ligamentum teres, but upon the femur head there is a flattened area, at the spot where in other mammals the ligament when present is usually attached.

B. 158. Left half of the pelvis and upper part of the femur of a Three-toed Sloth (*Bradypus tridactylus*). The joint-cavity has been opened to show the entire absence of a ligamentum teres.

B. 159. Right hip-joint of an Armadillo (*Dasypus sexcinctus*). The joint-cavity has been exposed to show the great size of the ligamentum teres. It has an extensive origin from the anterior margin of the cotyloid notch and from the capsule in its neighbourhood.

B. 160. Right hip-joint of a young Pangolin (*Manis pentadactyla*). The ligamentum teres is absent.

Presented by Dr. J. Anderson.

B. 161 Right hip-joint of a foetal Elephant (*Elephas africanus*). The ligamentum teres is absent.

B. 162. The head of the right femur of an Elephant (*Elephas indicus*) three years old.

The cartilaginous articular surface is uniformly smooth, having no depression for the insertion of the ligamentum teres. O. C. 255 E.

B. 163. Left hip-joint of *Procavia* [*Hyrax*] *capensis*. The ligamentum teres is fused with the capsular ligament.

- B. 164.** Right hip-bone of a fœtal Horse (*Equus caballus*) with a portion of the head of the femur. The ligamentum teres is separable into two well marked divisions. The one (cotyloid) lies entirely within the joint-cavity ; the other (pubio-femoral) passes from the femur head through the cotyloid notch and is attached to the pubis, pubic tendons of the abdominal muscles, and tendon of origin of the pectineus. Its close relation to the pectineus has led some to regard the ligamentum teres as a divorced tendon of that muscle.

Sutton, Ligaments, etc., London, 1882, p. 38.

- B. 165.** The left os innominatum and femur of a Seal (*Phoca vitulina*).

The capsule of the hip-joint is partly removed, and the head of the thigh-bone turned out of the cotyloid cavity, showing it to be quite smooth, without any depression for a ligamentum teres, which is absent in this animal : the cotyloid cavity has, however, the usual notch and depression, the latter being filled with fatty membranous substance.
O. C. 255 B.

- B. 166.** Right os innominatum and femur of a young Walrus (*Odobænus* [*Trichechus*] *rosmarus*). The femur is dislocated and the capsule of the joint removed to show the absence of the ligamentum teres. O. C. 255 B a.

- B. 167.** The left os innominatum and upper part of the femur, with a section of the lumbar, sacral, and coccygeal vertebræ, of an Orang-Outang (*Simia satyrus*).

The hip-joint is laid open, and the head of the thigh-bone dislocated and turned forwards, to show its smooth and uniform spherical articular surface, having no depression for a ligamentum teres, which is absent in this species.
O. C. 255 I.

- B. 168.** Right hip-joint of a young male Orang-Outang (*Simia satyrus*). The ligamentum teres is absent, but a peculiar mark on the head of the femur may indicate its presence at a still earlier period.

B. 169. Right hip-joint of a Chimpanzee (*Anthropopithecus troglodytes*), showing the ligamentum teres.

B. 170. The parts constituting the Human hip-joint of the right side.

The anterior part of the capsular ligament is turned back to show the extent to which the synovial membrane is reflected over the anterior part of the neck of the thigh-bone ; the thickness of the ligamentous part of the capsule is also shown by the section. In the cotyloid cavity may be observed the ligamentum teres, round which a bristle is tied, and the depression containing the fatty and synovial substance. O. C. 256. *Hunterian.*

KNEE.

B. 171. The parts constituting the knee-joint of an Ostrich (*Struthio camelus*), injected.

A section has been made through the patella, and the anterior part of the joint is laid open to show the crucial ligaments, and a very large tendon passing through the joint to be attached to the front of the external condyle ; also a tendon passing through a synovial sheath in the ligament of the patella, in an oblique direction from the femur to the tibia. Posteriorly, the capsular ligament is removed, to show the semilunar cartilages and the ligament connecting the external one to the head of the fibula, which in this class of animals is articulated with the external condyle of the femur, and forms part of the knee-joint.

The blood-vessels upon the inner condyle are successfully filled, and exhibit numerous mutual anastomoses as they approach the articular cartilage, forming what Dr. Hunter termed "the *Circulus articuli vasculosus* ; the vascular border of the joint." O. C. 272. *Hunterian.*

B. 172. The parts constituting the knee-joint of the *Ornithorhynchus anatinus*.

The articular cavity is divided into two compartments by a continuation and extension of the ligamentum mucosum from the back of the patella to the crucial ligaments ;

there being one synovial cavity common to the patella and anterior part of the femur, with the internal condyle and tibia, containing the internal semilunar cartilage; and a second common to the external condyle of the femur and tibia, with the head of the fibula, in which is contained the external semilunar cartilage.

The fibula has been rotated forwards to show a large facet upon the inner surface of its head, that articulates partly with the femur and partly with the outer surface of the head of the tibia.

- B. 173.** Right knee-joint of Koala (*Phascolarctus cinereus*) opened from behind.

The head of the fibula shares in the formation of the joint, articulating by a small facet with the side of the external condyle of the femur. A small nodule of cartilage (fabella) in the tendon of the gastrocnemius, articulates by a facet with the posterior surface of the head of the fibula. There is no bony patella.

- B. 174.** Lower portion of the right hind limb of a Tasmanian Devil (*Sarcophilus* [*Dasyurus*] *ursinus*) showing the knee- and ankle-joints. The head of the fibula has a small facet upon its apex for articulation with the femur, and a larger one upon its outer side which articulates with a nodule of bone attached by ligament to the shaft of the femur above the external condyle and to the head of the fibula. The external lateral ligament has been divided to show another ligament beneath it, that passes diagonally backwards from the lower and outer surface of the external condyle of the femur, and is attached by two branches to the anterior and posterior surfaces of the head of the fibula.

- B. 175.** Right knee-joint of a Fruit Bat (*Pteropus edwardsii*) opened from in front. There are no interarticular cartilages.

- B. 176.** The parts constituting the knee-joint of a Calf (*Bos taurus*).

The patella is turned down, to expose the anterior part of the joint; and on the opposite side the capsular ligament

is removed, to show the intervening semilunar cartilages and crueial ligaments. This joint has in this animal a partial septum extending aecross it (apparently a greater development of what is ealled Ligamentum mucosum in the human subject), which divides it into an anterior and posterior eavity. O. C. 296. *Hunterian.*

- B. 177.** A vertical section of the parts constituting the knee-joint of the same animal, showing the ligamentum mucosum, producing an almost distinct anterior cavity between the patella and eondyle of the femur, and a posterior one between the troehlea and head of the tibia. O. C. 270.

Hunterian.

- B. 178.** The counterpart of the preceding preparation. O. C. 271.

Hunterian.

- B. 179.** Left knee-joint of *Lemur mongoz*, opened from behind. The posterior extremity of the external semilunar cartilage is attached by a long ligament to the outer surface of the internal condyle of the femur. In a similar way the internal semilunar cartilage is attached by ligament to the inner surface of the head of the fibula. The external lateral ligament is double ; its inner fasciculus may represent a divorced portion of the popliteus tendon.

Presented by Prof. F. G. Parsons.

- B. 180.** The parts constituting the Human knee-joint.

The patella and part of the capsule are turned down to show the ligamentum mucosum within the joint and the anterior crueial ligament ; the extent of the synovial membrane and the line of its reflection upon the condyles of the femur ; the capsule is removed from the posterior part of the joint to show the interartieular semilunar cartilages and the posterior crueial ligament. The lateral ligaments and part of the tendon of the popliteus are also shown. O. C. 265 A.

- B. 181.** The interartieular semilunar cartilages from the Human knee-joint, injected ; showing their transverse connecting

ligaments, and the different character of the upper and lower parts for adapting a convex to a flat surface. O. C. 266. *Hunterian.*

- B. 182.** Small portion of the articular end of a femur. The cartilage has been broken, it shows a vertical striation of the fractured surface due to the cells being mostly disposed in vertical rows. A thin layer of the free surface projects, the cells being flattened and in horizontal layers. O. C. 267. *Hunterian.*

William Hunter, Phil. Trans., vol. xlii. 1742-3, p. 514.

Hanmar, Arch. f. Mikr. Anat., Bd. xliii. 1894, p. 813.

ANKLE.

- B. 183.** The tendons and ligaments of the joint between the tibio-tarsus and tarso-metatarsus of an Ostrich; the thickened tendon has been removed to show the interarticular cartilage at the back part of the joint. O. C. 275 A.

- B. 184.** Right ankle-joint of a Duck-billed Platypus (*Ornithorhynchus anatinus*). The internal malleolus of the tibia is strongly developed and articulates by an outwardly turned rounded head with a deep pit on the inner surface of the astragalus—an arrangement strikingly similar to the peg and socket articulation between the fibula and astragalus in the Sloths.

The tibio- and fibulo-tarsal joints are entirely separated from one another by an antero-posterior synovial partition.

- B. 185.** Right ankle-joint of an Opossum (*Didelphys marsupialis*). There is a well-marked semilunar interarticular cartilage between the fibula and astragalus. It is attached in front to the astragalus, behind to the fibula.

- B. 186.** Left ankle-joint of a Tasmanian Devil (*Sarcophilus [Dasyurus] ursinus*). An interarticular fibro-cartilage is interposed between the fibula and astragalus. The natural irregularities in the posterior margin of the tibio-fibular articular surface are equalised by two nodules of bone imbedded in the posterior ligament.

- B. 187.** Left ankle-joint of a Three-toed Sloth (*Bradypus tridactylus*). The cavity of the joint has been opened in front to show a curious peg and socket arrangement by which the inturning of the sole by the powerful tibialis anticus is facilitated, and outward displacement of the foot during this movement prevented. The peg is formed by a conical extension of the lower extremity of the fibula; its point is directed diagonally inwards and downwards, and fits into a corresponding concavity in the upper and outer surface of the astragalus. A somewhat similar contrivance, though far less strongly marked, is found in certain Monkeys, *e. g.* *Nasalis*, in which the sole of the foot is inturned in climbing.

Humphry, Jour. of Anat. & Physiol., vol. iv. 1870, p. 22.

- B. 188.** Right ankle-joint of a Spider Monkey (*Ateles melanochir*). The external lateral ligament is in three fasciculi similar to those present in Man. The posterior portion of the capsular ligament has been reflected upwards to show the inter-articular cartilage attached to it.

- B. 189.** Lower ends of left tibia and fibula of a Spider Monkey (*Ateles melanochir*), showing the interarticular cartilage projecting from the posterior part of the capsule.

- B. 190.** Right ankle-joint of *Papio* [*Cynocephalus*] *sphinx*. The external lateral ligament is in two fasciculi, corresponding respectively to the middle and posterior fasciculus of Man.

Presented by Prof. F. G. Parsons.

C.

MUSCULAR AND ALLIED SYSTEMS.

PLANTS.

- C. 1. Two branches of *Desmodium gyrans* showing the diurnal and nocturnal positions of the leaves. There is no specialised motile organ, but the entire leaf-stalk (petiole) is straight during daylight from the uniform turgescence of its cells. In the dark, the cells of the upper half of the leaf-stalk becoming more turgid, causes the downward curvature.

Sachs, *Physiology of Plants* (Eng. trans.), p. 623.

- C. 2. Portion of a ternate leaf of *Erythrina corallodendron*, to show the part between the leaflet and petiole by which the motion of the leaflets takes place after sunset. O. C. 28.

“There is an action in plants which appears to be the contrary of expansion; it may be considered as a relaxation, or an action of those parts antagonizing the others which acted through the day, or at other periods, and it takes place at the time these other parts cease to act.

“This action has hitherto been considered as analogous to sleep in animals; whereas, sleep is a total loss of the sensitive principle, and all the actions dependent on volition for the time; and, therefore, can only take place in animals endowed with sensation. It is rather a defect in the animal, than an action, or the exertion of a principle.”—*John Hunter, MS. Croonian Lectures, No. 1.*

[The various actions that take place in plants at the close of day, are described by Linnæus in *Amœnitates Academicæ*, iv. p. 333, under the title *Somnus Plantarum*.]

Hunterian.

- C. 3. Leaves of *Hedysarum gyrans*, in which the small lateral leaflets have a power of moving up and down, with a varying degree of velocity, and without any mutual uniformity or co-operation. These motions take place independent of external stimulus. O. C. 31. *Hunterian.*

- C. 4. Portion of stem and leaves of *Hedysarum gyrans*. The main leaves assume the normal diurnal and nocturnal positions. The small lateral leaflets are in constant spontaneous periodic movement occupying a few minutes, the temperature must be high (at least 22° C.).
- C. 5. Two portions of stem with leaves attached of a Scarlet-runner (*Phaseolus multiflorus*). A swollen region at the bases of the main leaf-stalks and leaflets constitutes a special motile organ. In the absence of light the upper halves of the motile organs of the leaflets become more turgid, causing the leaflets to droop; at the same time the motile organ of the main leaf-stalk becomes more turgid below, thus raising the leaf-stalk into a more vertical position.
- C. 6. A branch of *Mimosa pudica*, with two leaves; one of them is in the expanded state; the other contracted, but erect. O. C. 29.

“Although one only of the pinnules be touched, the contractile movement is quickly propagated along the other three: it consists of an approximation of the upper surfaces of the opposite subleaflets to each other, with an overlapping of those of the same side.”—*John Hunter, MS. Croonian Lectures, No. 1.*

Hunterian.

- C. 7. Two portions of stem with leaves attached of a Sensitive Plant (*Mimosa pudica*). The diurnal and nocturnal positions are shown. The nocturnal position is rapidly assumed on the slightest irritation. It probably is of use in protecting the leaves from injury by tropical rain-storms. Special motile organs are well defined.

ANIMALS.

INVERTEBRATA.

- C. 8. Part of the margin of a large Medusa (*Rhizostoma carulea*), on the inferior edge of which the membrane is disposed in numerous minute plicæ, running in the direction of the circumference, and giving to it a fibrous or muscular appearance.

The muscle-fibres of Medusæ are derived from the ectoderm, and each consists of an elongated contractile fibril connected with either a superficial epithelial cell or with one that has migrated into the mesoglœa. The fibres are mainly present as a circular layer in the sub-umbrella, and in this region show a very definite transverse striation, connected no doubt with the sharp swimming contractions of the bell. O. C. 55. *Hunterian.*

O. & R. Hertwig, *Der Organismus der Medusen*, Jena, 1878, p. 7.

- C. 9. Two specimens of the Sea-Anemone (*Actinia mesembryanthemum*). The upper of the two is expanded, the lower contracted. The contraction is due to muscle-fibres situated in the mesoderm, but for the most part, as in Medusæ, either connected with or derived from the ectoderm. The fibres are smooth. O. C. 55 A.

O. & R. Hertwig, *Jena. Zeitschr.*, Bd. xiv. 1880, p. 42.

- C. 10. Masticatory apparatus (lantern of Aristotle) and neighbouring portion of the test of *Echinus esculentus*.

The points of the five teeth project through the central opening in the peristomal membrane. Each of the teeth is supported by a "pyramid," composed of two "alveoli," connected at the base by two pieces forming the "transverse arch." The pyramids (jaws) are locked together by five falces or braces; over these are the five slender radii or compasses. The muscles may be divided into four groups, viz.: five pairs of protrusors of the jaws, they arise from the actinostome between the auriculæ, and are chiefly inserted into the transverse arch; five pairs of retractors of the jaws and openers of the mouth, arising from the auriculæ and inserted near the tips of the jaws; five that arise from, and are inserted into, the neighbouring faces of the pyramids, that approximate the teeth; and five inter-radials, that prevent the downward dragging of the outer furcate ends of the radii when the jaws are protruded, they might slightly tend to protrude the jaws, but this is already provided for by other muscles. All the muscles

are unstriped. Five pairs of ligaments (indicated by black bristles) spring from the actinostome and are attached to the furcate outer ends of the radii ; they prevent the raising of this end by the contraction of the interradiial muscle.

- C. 11. Section of an Echinothurid (*Asthenosoma hystrix*) showing the arrangement of the muscles, by whose contraction the alterations in form of the creature are produced. Two of the five pairs of muscle-sheets are shown. They lie in the boundary lines between the ambulacra and inter-ambulacra, taking origin from the outer ends of the ambulacral plates. Each muscle-sheet is of crescentic form and composed of more or less isolated bundles. The latter radiate from a central tendon to the test. The fibres are smooth.

P. & F. Sarasin, *Ergebnisse Naturwiss. Forschungen auf Ceylon*, Bd. i. 1888, p. 93.

- C. 12. A Sea-Cucumber (*Holothuria tubulosa*) laid open from the dorsum to show the muscles of the body and cloaca. The muscles of the body-wall consist of an outer circular and an inner longitudinal layer. The latter is strongly developed and is broken up into five radial bands, each divided down the middle by a conspicuous furrow. Each band originates from the calcareous ring around the œsophagus and extends without interruption to the posterior extremity of the body. A large number of fine branching strands of muscle radiate outwards from the cloacal wall to the neighbouring parts of the body-wall. They act as dilators of the cloaca.

- C. 13. Another specimen of *Holothuria tubulosa*, cut open to show the muscles of the body-wall. O. C. 56. *Hunterian*.

- C. 14. The dermo-muscular tube of a Gephyrean worm (*Sipunculus nudus*) opened along the dorsal surface.

There are three muscle-layers in the body-wall, whose fibres (beginning with the outermost layer) have, respectively, a circular, diagonal, and longitudinal direction. In each layer the fibres are grouped together in regular parallel bundles. There are four retractor muscles of the intro-

vert, which originate from the longitudinal layer on a level with the anus and are inserted at the base of the tentacles. The individual muscle-fibres consist of an outer sarcolemma, a spirally fibrillated contractile cortex and a central protoplasmic portion. Upon the right, several of the longitudinal bundles have been removed to show the underlying diagonal layer, and on the left the circular layer is similarly exposed by the removal of both longitudinal and diagonal layers. O. C. 56 A.

Andreae, Zeitschr. f. wiss. Zool., Bd. xxxvi. 1882, p. 228.

C. 15. A similar preparation of *Phascolosoma vulgare*. In this Gephyrean the muscles of the body-wall are far more delicate than in *Sipunculus* and are arranged in two layers only—longitudinal and circular—in both of which the fibres form a continuous sheet. The course of the fibres in the two layers can be seen where black paper has been inserted beneath them. O. C. 56 B.

C. 16. Right half of a Sea-Mouse (*Aphrodite aculeata*) showing the muscular system, which in this worm attains a very high degree of complexity. The muscle-layers of the body-wall are broken up into a number of individual muscles, the most conspicuous of which are six longitudinal bands—a pair along the dorsum contiguous with each other, a ventral pair separated by an interval of 7 mm., and a single band along each side. The dorsal and ventral bands are continuous from end to end of the body, but the lateral bands are interrupted and firmly attached to the body-wall between each segment by a tendinous intersection. The muscles of the outer (circular) layer form a network of diagonal and transverse bands that pass between and superficial to the longitudinal bands. The interstices between them are occupied by the hepatic cæca. A large series of perpendicular and diagonal muscles traverse the body-cavity between each segment, and each parapodium has its own particular protrusor and retractor muscles. O. C. 57 A a.

C. 17. Portion of a Nereis (*Nereis foliosa*) showing two series of muscles, which extend along the dorsal aspect from one

end of the animal to the other ; these are intersected at regular distances, corresponding to the breadth of the segments. O. C. 58.

Quatrefages, Ann. Sci. Nat., ser. 5, t. xi. 1869, p. 309.

- C. 18.** Two specimens of a Leech (*Hirudo medicinalis*). The upper specimen is a transverse section taken through the middle of the body. The viscera have been removed to show several muscular strands passing perpendicularly through the body from the dorsal to the ventral wall, their contraction flattening the body for swimming. These muscles lie between the gastric pouches within metamERICALLY disposed connective-tissue lamellæ. The individual muscle-fibres are branched at either end. The lower specimen shows the longitudinal muscles which form the inner and most powerful layer of the body-wall. They are specially developed along the ventral mid-line. The muscle-fibres are spindle-shaped cells composed of longitudinally fibrillated cortex of contractile substance, surrounding a central core of undifferentiated protoplasm within which lies the nucleus. The protoplasm of the core extends to the periphery of the cell between the cortical fibrils. O. C. 57 A.

Leuckart, Die Parasiten des Menschen, Bd. i. 1894, p. 568.

- C. 19.** A Leech (*Hirudo medicinalis*), having part of its external tegument dissected off to show its longitudinal subcutaneous muscles. O. C. 57. *Hunterian.*

- C. 20.** A Brachiopod (*Terebratella cruenta*) from which the viscera and a portion of the left side of the valves have been removed to show the valvular and peduncular muscles. The former—concerned in opening and closing the valves—consist of two pairs of occlusors and a pair of divaricators. The two occlusors of either side arise from the dorsal valve slightly in front of the hinge ; for the first part of their course they are independent and fleshy, but about the middle of the body they assume a tendinous appearance, unite with one another, and are finally inserted by a common expanded

end to the ventral valve. The fibres of the posterior oclusors (indicated by black paper inserted beneath them), unlike those of all the other muscles, are transversely striated. The striped musele probably first suddenly closes the valves, the closed state being maintained by the unstriped anterior oclusors. The divaricators rise from the ventral valve alongside the insertion of the oclusors, and are inserted upon the eardinal processes of the dorsal valve external to the hinge-fulcrum. The peduncular muscles give rise to the slight movements of the valves upon the stalk; there are two pairs passing to either valve from the sides of the pedunele.

Presented by Prof. G. B. Howes.

Hancock, Phil. Trans., vol. cxlviii. 1858, p. 795.

- C. 21. A Cirripede (*Lepas anatifera*) dissected from the right side to show the muscular system. The most important muscles are:—An adductor, passing transversely between the scuta, for the closure of the valves; a group of longitudinal muscles on the carinal body-wall, apparently to retract the animal into its shell; a series of museles passing transversly from side to side in the position of the deeapod sternum; and the various muscles of the appendages. The majority of the muscle-fibres are transversely striated, but smooth fibres occur in the adductor muscle, mantle and pedunele. O. C. 54 A.

C. Darwin, Monograph of the Cirripedia, Ray Soc. 1851, p. 39; Gruvel, C. R. Acad. Sci., t. cxxiii. 1896, p. 68.

- C. 22. The stem of the Eared Barnacle (*Conchoderma aurita*), deprived of its external theca to show two series of oblique muscular fibres which arise from a central line or tendon on one side of the stem, and, winding spirally round, are inserted into a similar line on the opposite side of the stem. Beneath these oblique fibres, whose office is to compress the peduncle, others may be observed which are longitudinal, for the purpose of shortening the pedunele. O. C. 62, *Hunterian.*

- C. 23. The sheath of an Acorn-shell (*Balanus porcatus*), laid open to show the attachments of the muscles to the moveable opercular valves. O. C. 54. *Hunterian*.

C. Darwin, Monograph of the Cirripedia, Ray Soc. 1854, p. 61.

- C. 24. Longitudinal section of a Lobster (*Homarus vulgaris*), showing the muscles attached to the right half of the body. The chief muscles are indicated by numbers as follows. 1. Adductor of the eye-stalk. 2. Anterior gastric. 3. Levator of antenna. 4. Depressor of antenna. 5. Sternal levator. 6. Adductor of mandible. 7. Posterior gastric. 8. Tergo-epimeral. 9. Flexor of coxopodite of chela (acting as an adductor of the whole leg). 10. Extensor of basipodite of chela (acting as depressor of the leg). 11. Intersternal. 12. Deep abdominal extensor. 13. Abdominal rotator. 14. Deep abdominal flexor (enveloping portion). 14*. Its transverse portion. The most noteworthy of this highly specialised series of muscles are those connected with the movements of the abdomen. They consist of extensors (12), flexors (14), and rotators (13). Both flexors and extensors are composed of superficial and deep layers, the former in each case being very poorly developed. The deep flexor is a remarkable muscle both on account of its size and its complicated formation. It rises on either side from abdominal and cephalothoracic regions and extends to the telson, with attachments to each abdominal segment. Broadly speaking, it is composed of a central core of fibres around which an enveloping sheet (14) is coiled in a spiral. In each segment offshoots (14*) from the central core run transversely across the body to the central core of the muscle of the other side. The enveloping fibres with additions from the central core are attached to the anterior margin of each abdominal sternite, but the main part of the central core is attached to each tergum above the hinge-line, so that the action of the muscle is partly one of extension although mainly of flexion.

Owing to the immobility of the cephalothorax, the

muscles belonging to this region are rudimentary. The muscle-fibres are transversely striated. O. C. 61 B.

Parker & Rich, Macleay Memorial Volume, p. 159.

C. 25. Muscles of some right appendages of a Lobster (*Homarus vulgaris*).

A. Proximal part of a thoracic appendage showing the muscles of the two basal podomeres—coxopodite and basipodite. Owing to the shortness of these two segments, their muscles move the limb as a whole, giving rise to adduction, abduction, elevation, and depression. The muscles of both podomeres rise from the endophragm. They are indicated by numbers, thus:—1. Flexor of coxopodite=adductor of limb. 2. Flexor of basipodite=levator of limb. 3. Extensor of basipodite=depressor of limb. 4. Extensor of coxopodite=abductor of limb.

B. An abdominal appendage. The muscles are simple in their arrangement and produce backward and forward movements of the limb and abduction and adduction of the exopodite. 1. Extensor. 2. Flexor. 3. A complex mass of muscle, the proximal part of which forms a continuation of 1 & 2, while the distal part is composed of adductor and abductor of the exopodite.

C. The Mandible. The adductors (1, 2, 3) are both numerous and powerful, the abductors (4, 5) comparatively weak.

D. The Tail-fin and Telson. The main muscles are those concerned with flexion (1) and extension (2) of the tail-fin. Besides these, there are muscles (3, 4) for the adduction of the fin as a whole and (6, 8) of the exopodite, as well as (5, 7) for the abduction of the exopodite. The last four muscles would also to a certain extent have powers of extension and flexion. O. C. 61 c.

C. 26. A section of the claw of a Lobster (*Homarus vulgaris*), showing the fibres of the penniform muscle arising from the propodite and inserted into the apodeme of the dactylopodite. O. C. 60.

Hunterian.

- C. 27. A section of the propodite and dactylopodite of the claw of a Lobster, showing the attachment of the penniform adductor from another point of view. O. C. 61.

Hunterian.

- C. 28. Portion of the claw of a Lobster (*Homarus vulgaris*), opened to show the points of attachment of the adductor and abductor of the dactylopodite, and the great contrast between them in size and power. O. C. 61 D.

- C. 29. Leg of a Crab (*Cancer pagurus*) in which the several segments of the limb have been opened to show a pair of involutions of the shell (apodemes), which extend upwards from the upper margin of each segment (podomere) into the cavity of that next above it. They are situated opposite each other in a plane at right angles to that occupied by the fulcra of the joint and serve as surfaces of attachment for the muscles of the leg. Being part of the exoskeleton they are cast with it in exuviation. In each joint the plane of the fulcra is nearly at right angles to that of the next joint above and below, so that by a suitable combination of simple hinge-movements a great range of motion can be attained. O. C. 61 A.

List, Morph. Jahrb., Bd. xxii. 1895, p. 392.

- C. 30. A section of the larva of a large North American Moth (*Bombyx regalis*) showing two lateral series of muscles, which extend along the dorsal and ventral aspects, through the whole length of the body. These are intersected at determinate distances, corresponding to the several segments to which they are to give motion, and which have, also, their own peculiar muscles. O. C. 59.

Hunterian.

- C. 31. A freshwater Mussel (*Anodonta cygnea*), of which part of the right valve is removed, and the mantle dissected away, to show a pair of muscles (retractor pedis posterior) going obliquely from their origin upon the valves, in front of the posterior adductor, to their insertion on the foot. O. C. 53.

Hunterian.

- C. 32. Right valve of a Mussel (*Anodonta cygnea*), showing the pallial, adductor, and pedal muscles. The former consists of the muscular border of the mantle. The two adductors of the valves are cylindrical muscles of equal size that pass transversely from valve to valve at either end of the body. The pedal muscles form the bulk of the foot and extend as a thin envelope over the surface of the visceral mass; definite anterior and posterior pedal retractor muscles can be distinguished from the general sheet, attached to the valves directly behind the anterior and before the posterior adductors. The contractile cortex of the individual muscle-fibres is either longitudinally fibrillated or shows a double diagonal striation probably due to spiral fibrillation. O. C. 52 A a.

Engelmann, Arch. ges. Physiol., Bd. xxv. 1881, p. 553.

- C. 33. Right valve and muscular parts of an Edible Mussel (*Mytilus edulis*). The anterior adductor of the valves is considerably smaller than the posterior. The pedal muscles are very strongly developed. They consist on either side of an anterior retractor pedis, attached to the valve above the anterior adductor, and a series of 6 or 7 posterior retractors attached in a horizontal line anterior to the posterior adductor. The posterior members of the series are inserted upon the margins of the byssal gland. O. C. 51 c.

Sabatier, Ann. Sci. Nat., ser. 6, t. v. 1877, p. 9.

- C. 34. Right valve and muscles of a Clam (*Mya arenaria*). The posterior part of the mantle is modified to form two muscular tubes (the siphons) in which the fibres run in circular radial and longitudinal directions. The longitudinal layer is greatly developed, and forms a pair of definite siphonal retractors. They have a very characteristic crescentic attachment to the shell (pallial sinus), continuous with that of the general mantle-border. Midway between the anterior and posterior retractor pedis muscles is a small elevator pedis. O. C. 52 A b.

- C. 35. The valves of a Cockle (*Cardium edule*) from which the

ventral parts have been removed, to show the fibres of the two adductor muscles. O. C. 52. *Hunterian*.

C. 36. A vertical section through the umbo of a Cockle (*Cardium edule*). The viscera have been removed to show the posterior adductor and posterior retractor pedis muscles. O. C. 52 A.

C. 37. Two specimens of *Pholas* [*Dactylina*] *dactylus*, giving a superficial and median view of the muscular system. The anterior adductor muscle lies almost entirely external to the hinge-line, attached to a special upward reduplication of the shell, and in consequence its contraction produces an abduction of the valves, the elastic ligament that generally performs this function being absent. An additional adductor of the valves is formed by an enlargement of the postero-ventral border of the mantle. In the lower specimen a fan-shaped anterior retractor pedis muscle is shown attached to the anterior and ventral margins of the falciform process. O. C. 53 D.

Egger, Arb. Inst. Würzburg, Bd. viii. 1888, p. 151.

C. 38. Right valve of a Scallop (*Pecten maximus*) with the chief muscles attached. One adductor (the posterior) alone is present, it is readily divisible into two portions—a large anterior part of a greyish colour, and a very much smaller, glistening white posterior part. The grey portion is composed of transversely striated muscle-fibres. The white portion consists of longitudinally fibrillated smooth fibres. Experiments show that the grey portion is capable of very rapid and transitory, the white of slow and prolonged contraction.

The striped muscle is the main agent in swimming, by the sudden closure of the valves a number of times in rapid succession. It also probably serves, as in the case of *Terebratella*, for the swift closure of the valves in case of danger, the almost tendinous smooth muscle maintaining the closure.

The pedal muscles are represented by a much reduced left posterior retractor. O. C. 51 B.

Blanchard, Bull. Soc. Zool. France, t. xiii. p. 76 ; Knoll, S.B. Akad. Wien, Bd. ci. Abt. 3, 1892, p. 481.

- C. 39. A vertical section through the umbo of a Scallop (*Pecten maximus*), showing the position and direction of the adductor muscle. O. C. 51 A.
- C. 40. A vertical section of the valves of an Oyster (*Ostrea edulis*), showing the adductor muscle and the disposition of its fibres at right angles to the shell. O. C. 50. *Hunterian*.
- C. 41. The lower flattened valve of an Oyster, showing by a transverse section the extent and shape of the adductor muscle. O. C. 51. *Hunterian*.
- C. 42. Right valve of *Anomia ephippium*, showing the muscular system. Close in front of the single adductor of the valves is a large posterior retractor pedis which runs transversely across the body from the left valve to the byssal plug. A small fan-shaped muscle runs forward from the anterior edge of the byssal plug and is attached to the right valve near the hinge. There is also a small anterior retractor pedis on the left side.
v. Ihering, Zeitschr. f. wiss. Zool., Bd. xxx. 1878, p. 13.
- C. 43. A Tectibranchiate mollusc from which part of the dorsal integuments have been removed to show a sheet of interlacing muscle-strands beneath. O. C. 62 A.
- C. 44. The muscular parts of an Ormer (*Haliotis tuberculata*), showing a modification of the columellar muscle related to the sucker-like character of the foot. The muscle has the form of a massive truncated cone attached by its apex to the shell slightly to the right of the mid-line and spreading out below to form the substance of the foot. A section of the muscle has been cut to show its dense felted texture. O. C. 53 B. *Presented by F. Hutchesson, Esq.*
- C. 45. The muscular system of a Limpet (*Patella vulgata*), showing a somewhat similar modification of the columellar muscle. At its origin, the muscle has the form of a backwardly directed horseshoe, from which the muscle-fibres pass directly into the foot converging towards the mid-line.

A shell with the muscle attachments outlined in red is mounted below. O. C. 52 A c.

Harvey Gibson, Trans. R. Soc. Edin., vol. xxxii. 1885.
p. 621.

- C. 46. A Heteropod (*Carinaria mediterranea*), from the left side of which the integuments have been removed to show the arrangement of the muscles of the body-wall. They consist of a number of anastomosing bands that completely surround the anterior parts of the body, and are specially numerous in the fin (chiefly propodium), but become fewer and more scattered in the metapodium. The mesopodium is represented by a sucker upon the postero-ventral margin of the fin. They fall into three main groups according to their direction within the body-wall. i. A series rising from the dorsum and passing diagonally backwards round the sides to the ventral surface. ii. The converse of the preceding, passing backwards from the ventral to the dorsal surface. iii. Very delicate circumferential bands. The muscle-fibres are smooth.

Kalide, Zeitschr. wiss. Zool., Bd. xlvi. 1888, p. 345 :

Wackwitz, Zool. Beitr., Bd. iii. 1892, p. 134.

- C. 47. Two specimens of a Snail (*Helix aspersa*), showing a compound retractor muscle (the columellar muscle) by means of which the whole anterior part of the animal can be withdrawn into the shell. The muscle originates in three bundles from the columella in the third coil of the shell ; the two lateral bundles spread out in the foot on either side of the mid-line, and also give off a slip of attachment to the apex of each tentacle ; the central bundle is inserted into the buccal mass. A small retractor penis passes diagonally across the body-cavity from the penis to the muscular floor of the pulmonary chamber. In the upper specimen the Snail is seen from the right, in the lower from the dorsal aspect. The several muscle-bundles are marked by black paper. O. C. 53 c.

- C. 48. A Cuttle-fish (*Sepia officinalis*) from which the skin and viscera have been removed to show the muscles.

The mantle and funnel have also been longitudinally

divided, and the two halves of each separated to expose the underlying trunk muscles. The most important of these are the retractor capitis (a compound muscle formed by the fusion of paired median and lateral retractors) and the depressor infundibuli; these two together probably represent the columellar muscle of the gastropod.

The right tentacle is extended, the left coiled up within its pouch.

The muscle-fibres show a very marked double diagonal striation due apparently to the spiral arrangement of the fibrils of the contractile cortex. O. C. A 63.

Brock, *Morphol. Jahrb.*, Bd. vi. 1880, p. 202; Bal-
lowitz, *Arch. f. Mikr. Anat.*, Bd. xxxix. 1892, p. 291.

- C. 49. A transverse section of one of the arms of a large Cuttle-fish (*Onychoteuthis*, Lichtenstein, 'Isis von Oken,' A.D. 1818, tab. xix. See also *Loligo banksii*, No. 166 D. Catal. Nat. Hist. p. 33), showing the complex arrangement of the muscular fibres. O. C. 63. *Hunterian.*

- C. 50. Right half of the muscular body-wall of a Tunicate (*Phallusia mammillata*). The muscle-fibres run in all directions over the body, forming an intricate network. A more regular circular arrangement is noticeable around the oral and atrial apertures.

- C. 51. Muscular body-wall of a Tunicate (*Ciona intestinalis*). The muscle-fibres are arranged more regularly in longitudinal and circular layers than in *Phallusia*. The fibres that run in a longitudinal direction are gathered together into definite bundles. The individual fibres are very long and of the smooth variety.

Roule, *C. R. Acad. Sci.*, t. xcv. 1882, p. 45.

- C. 52. Asexual form of *Salpa africana maxima*, showing the muscular system. The trunk-muscles consist of 9 isolated ribbon-like bands, situated at intervals along the dorsum transverse to the long axis of the body. They extend on either side as far as the mid-lateral line. Around the mouth and atrial aperture are several smaller muscles, the most

important of which form sphincters. By the contraction of the trunk muscles the water in the pharynx and atrial chamber is forcibly expelled from the atrial aperture, and the animal is in consequence propelled in an opposite direction. The muscle-fibres show a distinct transverse striation.

Knoll, Denkschr. d. k. Akad. Wiss. Wien, Bd. lviii. 1891, p. 671.

- C. 53.** A preparation of the trunk muscles of *Amphioxus lanceolatus*. They consist of a series of open chevron-like muscle-plates (myotomes) arranged parallel to one another along the lateral parts of the body, with their apices directed forward and slightly above the mid-lateral line, those of opposite sides alternating. They are formed of longitudinal fibres, and are separated from one another and from those of the opposite side by a layer of connective tissue. They entirely surround the body with the exception of the ventral area of the atrial chamber, where a layer of transverse muscle is interposed between their ventral ends. The fibres of which these muscles are composed are transversely striated and have a highly characteristic plate-like form. The nucleus imbedded in a small quantity of undifferentiated protoplasm lies peripherally. There is no sarcolemma. The middle specimen shows the muscles in position after removal of the integument. On either side are several isolated myotomes showing their outer (on the right) and inner (left) surfaces. O. C. 63 A.

Langerhans, Arch. f. Mikr. Anat., Bd. xii. 1876, p. 291.

VERTEBRATA.

FORM AND TEXTURE.

Texture of Muscle.

- C. 54.** Portions of muscle from a Cod-fish (*Gadus morrhua*), which have been steeped in an acid, and reflect iridescent colour in some lights, due to striation producing interference. O. C. 36. *Hunterian.*

- C. 55. A portion of muscle from the neck of a Bull (*Bos taurus*) which has been boiled, and the connective tissue, vessels, and nerves removed from the lower part, and the muscular fasciculi unravelled. O. C. 33. *Hunterian.*
- C. 56. A portion of a muscle which has been steeped in acetic acid, and the fasciculi separated into their constituent fibres. O. C. 33 A. *Mus. Sir A. Cooper, Bart.*
- C. 57. A portion of the gastrocnemius muscle, injected, dried, and put into oil of turpentine to show its vascularity. O. C. 35. *Hunterian.*
- C. 58. A portion of a simple muscle, injected, dried, and put into oil of turpentine, to show its vascularity and the mode of ramification of its minute vessels. O. C. 35 A. *Mus. Sir Astley Cooper, Bart.*
- C. 59. A portion of a semi-penniform muscle, similarly prepared for the same purpose. O. C. 35 B. *Mus. Sir Astley Cooper, Bart.*
- C. 60. A portion of the diaphragm of a child, injected, dried, and put into oil of turpentine, to show the radiating disposition of the muscular fibres indicated by the blood-vessels. O. C. 37. *Hunterian.*

Texture of Tendon.

- C. 61. Portions of tendons from the leg of an Ostrich (*Struthio camelus*), which have in this animal an unusually brilliant lustre. O. C. 47. *Hunterian.*
- C. 62. Part of a muscle and tendon from the leg of a Crane (*Grus cinerea*), showing the method of insertion of the muscle-fibres into the superficial fan-shaped tendon. The tendon is sharply defined from the muscle-fibres and shows a strong tendency to ossification. O. C. 64 Y s a. *Presented by W. B. Tegetmeier, Esq.*
- C. 63. Section of one of the caudal tendon-bundles of a large Fin-whale (*Balænoptera musculus*). O. C. 45 E.

- C. 64. A tendon from the leg of a Calf (*Bos taurus*), injected, dried, and put into oil of turpentine, to show its small degree of vascularity. O. C. 49. *Hunterian.*
- C. 65. The Human tendo Achillis, injected, with part of the gastrocnemius muscle, to show by contrast the difference in the vascularity of these parts. O. C. 49 A.
Presented by Sir William Blizard.

Forms of Muscle.

- C. 66. A portion of the 'obliquus abdominis internus' of a Rhinoceros (*Rhinoceros unicornis*), showing the expanded form of tendon, termed 'aponeurosis.' O. C. 48 A.
- C. 67. A portion of the sartorius muscle of the Human subject to show the parallel straight direction of the muscular fibres. O. C. 37 A.
- C. 68. A muscle—the 'biceps brachii' of a Child, showing the aggregation of the fibres into two masses converging and uniting below into a single tendon of insertion, and forming a 'biceps' muscle. O. C. 45 A.
Mus. Sir Astley Cooper, Bart.
- C. 69. A muscle—the 'extensor antebrachii' of a Child, showing the arrangement of the fibres into three masses, united below into a single tendon of insertion, and forming a 'triceps' muscle. O. C. 45 B.
Mus. Sir Astley Cooper, Bart.
- C. 70. A muscle—the chief extensor of the leg of a Child, showing the arrangement of the fibres into four masses which unite below to be inserted, by the intervention of the patella, into the tibia. O. C. 45 c. *Mus. Sir Astley Cooper, Bart.*
- C. 71. A portion of double penniform muscle from a Whale (*Balænoptera musculus?*), showing this form of muscle and the coarseness of the muscular fasciculi. O. C. 41 A.

- C. 72. A section of a muscle, consisting of a single series of oblique fibres, constituting the half-penniform muscle. O. C. 38. *Hunterian.*
- C. 73. A section of a muscle, consisting of a double series of oblique fibres, constituting the complete-penniform muscle. O. C. 39. *Hunterian.*
- C. 74. A section of a penniform muscle. O. C. 40. *Hunterian.*
- C. 75. A section of a penniform muscle. O. C. 41. *Hunterian.*
- C. 76. A transverse section of a complex muscle, to show the intermixture of the muscular and tendinous fibres. O. C. 44. *Hunterian.*
- C. 77. A section of a muscle, in which the fibres are disposed obliquely in several double series, with tendon intervening; constituting the complex muscle. O. C. 42. *Hunterian.*
- C. 78. A longitudinal section of a complex or multi-penniform muscle. O. C. 43. *Hunterian.*
- C. 79. A transverse section of a complex muscle. O. C. 45. *Hunterian.*

REGIONAL.

Cutaneous.

In all classes above Fish, the names attached to individual muscles are taken from Bronn's Thier-reichs. An exception has however been made in the case of the hind limbs of the Lizard (Nos. C. 173 & C. 174), in which the names employed by Gadow (*Morph. Jahrb.* vii. 1882) have been substituted to facilitate comparison with the Crocodile.

- C. 80. The skin of a Hedgehog (*Erinaceus europæus*) with the head, limbs, and tail, showing the powerful cutaneous muscles by the action of which the Hedgehog is rolled into a ball and completely enveloped and protected by the dorsal spine-bearing region of the skin. They can be conveniently separated into those concerned with (1) rolling, and (2) unrolling. The first group comprises the large orbicularis panniculi, a broad muscular band peculiar to the Hedgehog;

closely adherent to the skin of the back along the border of the spine-bearing area, and a series of small muscles arising from the head, fore limbs, tail and ventral mid-line of the body, and inserted into the inner margin of the orbicularis panniculi. These latter muscles draw the extremities together and at the same time drag the orbicularis panniculi so far towards the ventral surface that it can act like the running string in the mouth of a bag and cause the complete enclosure of the animal in the spine-bearing region of the skin. Unrolling is caused by the action of the longitudinal and transverse fibres of the dorsal region of the skin, with the help of certain small muscles arising from the skull and vertebral column, and so arranged that they draw the skin towards the middle of the back. O. C. 64 z n.

C. 81. Head and fore limbs together with the anterior half of the skin of a Hedgehog (*Erinaceus europæus*), showing many of the cutaneous muscles in this region more clearly than in the previous specimen. O. C. 64 z o.

C. 82. Hind limbs and posterior half of the skin of a Hedgehog (*Erinaceus europæus*), showing the cutaneous muscles. O. C. 64 z p.

Himly, Ueber das Zusammenkugeln des Igels, Brunswick, 1801, p. 28.

Dobson, Monograph of Insectivora, 1882, p. 41.

Head and Neck.

Ruge, Festschr. Gegenbaur, Bd. iii. 1896, p. 195.

C. 83. Left half of the head and branchial region of a Dog-fish (*Scyllium catulus*), from which the skin has been removed to show the superficial muscles. These, with the exception of the large adductor mandibulæ, are all derivatives of a common superficial circular layer (constrictor arcuum), the main function of which is to expel the water from the pharynx through the gill-openings.

C. 84. Right half of the head and branchial region of the same Dog-fish showing the deeper branchial muscles. These

fall into three groups. 1. Interarcual muscles. 2. Adductors, serially homologous with the great mandibular adductor. 3. Ventral longitudinal muscles, these arise from the coracoid bar as a common mass and are inserted in pairs into the base of each visceral arch.

Vetter, Jena. Zeitschr., Bd. viii. 1873-74, p. 405.

- C. 85. Head of a Haddock (*Gadus æglefinus*), showing the superficial muscles of the left side. In this and other bony fish the muscles of the head are far more numerous and subdivided than in the Dog-fish, although their phylogenetic origin from similar simple muscle-sheets can be inferred with some degree of certainty. The specialization of the muscles is closely related to the greater number of skeletal parts and their increased mobility; it is particularly apparent in the adductor of the jaw and in the opercular muscles. In all probability the opercular palatine and hyoid muscles represent the great superficial constrictor of the Selachian.

Vetter, Jena. Zeitschr., Bd. xii. 1877-78, p. 489.

- C. 86. The muscles of the left branchial arches of a Haddock (*Gadus æglefinus*). The muscles are highly specialized and provide for a great variety of movement, both of the individual arches and of the branchial skeleton as a whole. The dorsal muscles in particular, owing no doubt to their connection with the pharyngeal toothed pad formed by the hypopharyngeal bones, show a high degree of complexity and can produce movements in anterior, posterior, dorsal and lateral directions.

- C. 87. Head of a Python (*Python sebæ*), showing the chief muscles. They fall into three groups. 1. Those concerned in the movements of the lower jaw, consisting of parieto-quadrato-mandibularis, analogous in function to the temporal and masseter of mammals; occipito-quadrato-mandibularis, analogous to the depressor maxillæ inferioris (digastric); transverso-maxillo-pterygoideo-mandibularis, analogous to the external pterygoid; and a curious pair of muscles (intermaxillares) that pass diagonally across the floor of the mouth from either mandibular joint to the anterior end of the

opposite mandible ; they check excessive divarication of the mandibular rami. 2. Those concerned with the movement of the palate—the pterygo-sphenoidalis posterior and anterior for the approximation of the posterior and anterior ends respectively of the pterygoids, and a levator of the pterygoid (pterygo-parietalis). 3. A retractor of the vomer (vomer sphenoides).

D'Alton, Arch. f. Anat., 1834, p. 348 ; Dugès, Ann. Sci. Nat., t. xii. 1827, p. 337.

- C. 88. Head and neck of a Rook (*Trypanocorax frugilegus*), in which the tongue and pharynx have been displaced to show the muscles of the jaws and hyoid. They are few and simple. The jaw is depressed by a single-bellied muscle, very similar in its position and general appearance to the depressor of *Ornithorhynchus* shown in No. C. 95. It is possibly homologous to the posterior belly of the mammalian depressor. The beak is closed by a double temporalis and a well-developed pterygoid. The geniohyoid is the most important muscle connected with the hyoid apparatus, it passes backwards from the lower jaw and is wound round the apex of the hyoid cornu—it protrudes the tongue. Retraction is caused by the styloglossus. O. C. 64 y n.

Shufeldt, Myology of the Raven, London, 1890, p. 15.

Presented by St. George Mivart, Esq.

- C. 89. Head and anterior part of the sternum of a Cape Hyrax (*Procavia [Hyrax] capensis*), showing certain muscles of the neck. From the upper ascending ramus of the jaw on either side there arises a voluminous muscle, whose fibres pass downwards and backwards—some of them are inserted upon the manubrium sterni, but the majority meet those of the corresponding muscle of the opposite side in a median raphé. The function and homologies of this muscle are obscure, but it possibly represents a migrated portion (sterno-maxillary) of the sterno-mastoid, such as occurs in the Horse and other Ungulates. Its presence gives the well-known puffy appearance to the neck of the Hyrax. O. C. 64 z m.

George, Ann. Sci. Nat., ser. 6, t. i. 1874, p. 102.

- C. 90. Portion of the hyoid bone of a Horse (*Equus caballus*), showing the hyoideus latus passing between the posterior cornu and the ceratohyal on either side, and a muscular band (hyoideus transversus) that unites the upper ends of the ceratohyals over the base of the tongue.

Presented by Prof. McFadyean.

- C. 91. Anterior portion of the lower jaw of a Seal (*Phoca vitulina*) showing the muscles of the intermandibular space. The mylohyoid is divided into two parts. The one situated 25 mm. behind the symphysis passes directly from one mandible to the other, and has much the characters of the transversus mandibulæ of Rodents. The second portion lies posterior and slightly dorsal to the first, its fibres pass obliquely forwards towards the mid-line, and there unite in a median raphé. The space in front of the mylohyoid is occupied by the anterior part of the geniohyoid.

- C. 92. Hyoid bone and epiglottis of a Dog (*Canis familiaris*), showing a well developed hyo-epiglottidean muscle. It arises by a separate head from the lower end of each ceratohyal; both heads pass backwards and upwards, unite, and are inserted in common upon the anterior surface of the epiglottis. O. C. 64 z q. *Presented by Prof. McFadyean.*

- C. 93. Head, thorax, and proximal part of the fore limbs of a Lemur (*Lemur mongoz*), showing the superficial muscles on the left, the deep on the right. The following points may be noted :—

(On the Left side). The division of the deltoid into three parts is very distinct. The two heads of the biceps are almost entirely separate, being only slightly joined towards their distal end. This condition is more usually found in *Galago* than in *Lemur*.—(On the Right side). The cleidomastoid is independent of the sterno-mastoid. The omohyoid has no tendinous intersection. The depressor maxillæ inferioris (digastric) is strongly digastric, a slender tendon (indicated by black bristles) passes from its inner border to the mylohyoid. O. C. 64 m b f.

Presented by Prof. F. G. Parsons.

Murie & Mivart, Trans. Zool. Soc., vol. vii. 1872, p. 12.

- C. 94. Head of Orang-Outang (*Simia satyrus*) with the skin removed from the left half to expose the superficial muscles. These are well developed upon the face, more especially in the protuberant mobile lips. They are extremely variable in the details of their arrangement, and their boundaries are very indistinct. This group of muscles is derived from the platysma myoides and sphincter colli, it is supplied by the 7th nerve, and can probably with safety be referred to the hyoid portion of the superficial constrictor of the Selachian. O. C. 64 M c. *Presented by C. Dent, Esq.*
 Ruge, Untersuchungen über die Gesichtsmuskulatur der Primaten, Leipzig, 1887, p. 2.

Depressor maxillæ inferioris (Digastric).

Dobson, Trans. Linn. Soc., vol. ii. 1882, p. 259 ; Parsons, Jour. Anat. & Physiol., vol. xxxii. 1898, p. 436.

- C. 95. Part of the skull of *Ornithorhynchus anatinus*, showing the masseter and depressor maxillæ inferioris (digastric) muscles. The depressor rises from the posterior border of the glenoid cavity and is attached to the ventral surface of the hinder part of the mandible. It is doubtful whether this muscle is homologous with the depressor of other mammals, in spite of its somewhat analogous position and action.
- C. 96. Skull of *Potorous* [*Hypsiprymnus*] *tridactylus*, with the depressor maxillæ inferioris (digastric) and mylohyoid muscles. The depressor is indistinctly digastric, the anterior and posterior bellies being separated from one another by a slight constriction and tendinous intersection. A few tendinous fibres pass from the intersection to the posterior margin of the mylohyoid. The anterior belly is attached to the mandible near the symphysis.
- C. 97. Head of a young Three-toed Sloth (*Bradypus tridactylus*) showing the chief muscles of mastication. The two bellies of the depressor maxillæ inferioris (digastric) are separated

by a weak tendinous intersection. The intersections of opposite sides are united by a subhyoidean tendinous arcade, which forms a base of origin for the anterior bellies. The latter occupy the whole of the intermandibular space.

C. 98. Skull of a Mole (*Talpa europæa*), showing the depressor maxillæ inferioris (digastric) muscles. They are of the monogastric type, interrupted on a level with the angle of the jaw by an extremely feeble tendinous intersection; they arise from the paroccipital region of the skull by a large fleshy origin and gradually taper to a fine tendon attached to the middle of the mandible, and also by a few fibres to the posterior margin of the mylohyoid.

C. 99. Skull of *Galeopithecus volans* with depressor maxillæ inferioris (digastric) and mylohyoid muscles. The depressors are monogastric with a feeble tendinous intersection. They are attached to the angles of the jaw. The anterior part of the mylohyoid is intimately bound to the geniohyoideus.

C. 100. Occiput and lower jaw of a Hare (*Lepus europæus*), showing the depressor maxillæ inferioris (digastric) muscles.

In this family of Rodents the depressor is monogastric, represented by the anterior belly alone; the place of the posterior belly is occupied by a long tendon attached to the paroccipital process. O. C. 64 z l b.

Parsons, Jour. Anat. & Phys., vol. xxxii. 1898, p. 441.

C. 101. Head of a Guinea-pig (*Cavia porcellus*), showing the masseter and depressor maxillæ inferioris (digastric) muscles. The anterior and posterior bellies of the depressors are separated from one another by a slightly constricted area the surface of which is tendinous. The anterior bellies are attached near the symphysis at either end of the transversus mandibulæ. O. C. 64 z l c.

Parsons, Jour. Anat. & Phys., vol. xxxii. 1898, p. 489.

C. 102. Skull of *Dasyprocta aguti*, with depressor maxillæ inferioris (digastric), mylohyoid, and hyo-epiglottidean

muscles. The two bellies of the depressor are separated, as in the Guinea-pig, by a constriction and superficial central tendon. A fine tendon connects the latter with the posterior margin of the mylohyoid. The intermandibular space close behind the symphysis is occupied by an independent portion of the mylohyoid (*transversus mandibulæ*): its contraction divaricates the lower incisors.

- C. 103. Head of a Fox-Squirrel (*Sciurus ludovicianus*), showing, from the ventral aspect, the depressor maxillæ inferioris (digastric) muscles. They are strongly digastric; the central tendons have an attachment to the hyoid, and by union with one another in the mid-line form a sub-hyoidean tendinous arch, from the anterior margin of which the anterior bellies arise. The latter are closely contiguous and occupy the median third of the intermandibular space. They are inserted at the symphysis menti. O. C. 64 *z l u*.
Parsons, Jour. Anat. & Phys., vol. xxxii. 1898, p. 438.

- C. 104. Part of the skull and hyoid bone of a Colt (*Equus caballus*) showing the depressor maxillæ inferioris (digastric) and stylohyoid muscles. The depressor is strongly digastric; its long central tendon perforates the tendon of attachment of the stylohyoid. A large part of its posterior belly is attached directly to the inner surface of the angle of the mandible. The stylohyoid is divided into two portions by the posterior process of the stylohyal. The proximal part (mastoideo-styloideus)—regarded by some as part of the depressor—passes from the paroccipital process to the stylohyal. The distal part rises by a slender tendon from the outer surface of the posterior process of the stylohyal.
Presented by Prof. McFadyean.

- C. 105. Occiput, hyoid, and lower jaw of a Sheep (*Ovis aries*), showing the depressor maxillæ inferioris (digastric), stylohyoid, mylohyoid, and hyo-epiglottidean muscles. The depressor is a strongly digastric muscle with its anterior belly attached far back upon the inner surface of the mandible and partly also into the mylohyoid. The mastoideo-styloideus is fan-shaped: the stylohyoideus rises

from the apex of the posterior process of the stylohyal; it runs over the outer surface of the depressor and is attached to the body of the hyoid.

- C. 106. Occiput and hyoid bone of a Calf (*Bos taurus*), showing the depressor maxillæ inferioris (digastric) and stylohyoid muscles. The mastoideo-styloideus portion of the stylohyoid is more developed than in the Sheep and extends for a considerable way down the inner surface of the stylohyal.

- C. 107. Skull of a foetal Seal (*Phoca vitulina*), showing the monogastric depressor maxillæ inferioris (digastric). The anterior part of the left depressor shows signs of longitudinal division. There is no tendinous intersection.

Miller, Challenger Reports (Zool.), vol. xxvi. 1888, p. 215.

- C. 108. Head of a young Otter (*Lutra lutra*) with mastoideo-styloideus, styloglossus, and parts of the depressor maxillæ inferioris muscles. The depressor (most of which has been removed) is monogastric. The stylohyoid is represented by its mastoideo-styloidean portion only.

- C. 109. Lower jaw of a Dog (*Canis familiaris*), showing the depressor maxillæ inferioris (digastric), mylohyoid, and stylohyoid muscles. The depressor is of the monogastric type, but sometimes—as in this specimen—shows a very delicate tendinous intersection on a level with the angle of the jaw. It is attached to the mandible near its middle. The stylohyoid muscles are very slender, that on the right sends a slip to the depressor, while the main part of the muscle vanishes before reaching the hyoid.

Presented by Prof. McFadyean.

Ellenberger & Baum, Anat. des Hundes, Berlin, 1891, p. 134.

- C. 110. Occiput and lower jaw of a Crested Baboon (*Cynopithecus niger*), dissected to show the depressor maxillæ inferioris (digastric) muscles. The posterior belly on each side terminates anteriorly in a long central tendon, which unites with its fellow of the opposite side to form a tendinous

subhyoid arch. The anterior bellies arise from the anterior margin of the arch and radiate from it as a single sheet to the mandibles. O. C. 64 M b c.

Parsons, Jour. Anat. & Phys., vol. xxxii. 1898, p. 438.

- C. 111. Left half of the head of an Orang-Outang (*Simia satyrus*), seen from the basal aspect. The depressor maxillæ inferioris (digastric) is represented only by the posterior belly. It is inserted by tendon upon the inner surface of the angle of the jaw. In many individuals traces of the anterior belly have been observed. O. C. 64 M c a.
- C. 112. Depressor maxillæ inferioris (digastric) muscles of a Chimpanzee (*Anthropopithecus troglodytes*). The general arrangement is very similar to *Cynopithecus* (C. 110). The central tendon perforates the tendon of attachment of the stylohyoid. O. C. 64 M c b.

Trunk.

- C. 113. Transverse section through the caudal region of a Dogfish (*Scyllium catulus*). In consequence of the complicated course and shape of each myotome, a large number of them are cut through in a single section. The concentric rings upon the section surface are the result of a series of hollow conical projections from the anterior face of each myotome, lying one within another and separated from each other by the intermuscular septa of fibrous tissue. O. C. 63 B.
- C. 114. Part of the vertebral column of a Mackerel (*Scomber scomber*), with a single myotome attached to the left side. The fibres of the myotome run longitudinally, attached by either end to a fibrous intermuscular septum that traverses the body in a dorso-ventral direction and is attached to vertebral column and superficial trunk-fascia in the form of a W with the base directed backwards. The median part of the myotome (*i. e.* the middle bend of the W) is prolonged forwards, above and below the mid-lateral line to

form a pair of hollow cones, which fit accurately into the cavity of the two similar cones of the myotome in front and are themselves filled by those of the myotome behind. Between and superficial to the bases of the cones there is a wedge of soft muscle of a dark reddish-brown colour. O. C. D *a*.

C. 115. Transverse section through the body of a Mackerel (*Scomber scomber*), showing the concentric rings due to the section of muscle-cones of successive myotomes and the division of the trunk-muscles into dorsal and ventral columns by a longitudinal lateral septum. The brown superficial lateral muscle in this specimen has assumed a lighter tone than the general trunk-muscles. The pattern formed by the cut edges of the intermuscular septa is here far simpler than in the Dog-fish, and indicates a less complicated form of myotome. O. C. 63 D *b*.

C. 116. A portion of the trunk of a Python (*Python sebae*), dissected from the left side to show the musculature external to the ribs. A lateral cutaneous muscle (cutaneus externus), composed of numerous ribbon-like strands, arises high up on each rib and passes downwards and backwards to the skin. It is opposed by the cutaneus internus, arising in separate fasciculi from the point of each rib and passing forwards to the ventral parts of the skin. On either side of the back there is a large composite mass of muscle, which forms a specially strong and important feature in the muscular system of the constricting serpents. Its chief components are the capito-vertebralis and the retractor costæ biceps. Beneath the strands of the cutaneus externus lies a sheet of muscle composed of intercostales superiores and inferiores, posteriorly they have been separated to show their attachments. Each fasciculus of these muscles passes over from 12-16 ribs between its origin and insertion. In the lower part of the specimen the intercostales proprii are visible, passing from rib to rib. O. C. 63 I.

D'Alton, Arch. f. Anat. 1834, p. 432.

- C. 117. The right half of a portion of the trunk of a Python (*Python sebæ*) seen from within ; to show the internal rib-muscles.

Dorsal to the origin of the abdominal muscles, there are two costal retractors ; of these two the internal (*M. costo-vertebralis superior*) is the most strongly developed. Its fasciculi arise from the hypapophyses of the vertebræ, and passing forward over 6 ribs are inserted in the seventh. The last three ribs in this specimen have been stripped, leaving only the costo-vertebralis inferior at their base ; this is a small muscle for the protraction of the ribs. O. C. 63 L.

- C. 118. Ventral body-wall and ends of the ribs of a Python (*P. sebæ*) seen from above, showing the abdominal and lower internal costal muscles.

The abdominal muscle (composed of two sheets intimately connected together) arises from the middle of each rib and passes diagonally across the body direct to the ventral middle line, where it is inserted in a strong aponeurosis. It tends to flatten the body during locomotion. The left half of this muscle has been retained, the right cut away, to show the ventral shield muscles and the cutaneus internus passing forward from the ribs to the skin. Two internal costal retractor muscles are shown on the right side, the one (*retrahens costarum brevis*) takes a longitudinal course between the points of the ribs ; the other (*retrahens costarum longus*) arises beneath the origin of the abdominal muscle and is inserted on the 5th rib in front, 6 mm. from the point. O. C. 63 K.

- C. 119. Transverse section through the body of a Python (*Python sebæ*), showing the position and double nature of the abdominal muscle-sheet. O. C. 63 N.

- C. 120. A portion of the ventral body-wall of a Python (*P. sebæ*) seen from above, showing the ventral shield muscles. The most conspicuous of these are the interscutales majores. They take their origin from the middle of the anterior edge of the ventral shields and pass outwards and backwards to

their insertion on the side scales 2 or 3 rows behind ; they tend to erect the free edge of the ventral shields.

Superficial to these muscles lie a series of more or less longitudinal muscles passing from shield to shield, they drag the scales individually forward, sliding one over the other. This action brings the free edges of the shields flat against the body. O. C. 63 m.

- C. 121. Posterior extremity of the tail of a Spider Monkey (*Ateles* sp.). The skin has been removed from the dorsal surface to show the mode of attachment of the tendons to the ventral skin. O. C. 64 m *b b*.

Fore-limb.

- C. 122. Right pectoral fin of a Dog-fish (*Scyllium catulus*). Several fairly distinct off-shoots from the trunk-muscles enter into direct relations with the shoulder-girdle and foreshadow the trapezius, latissimus dorsi, and pectoral muscles of higher vertebrates. The limb-muscles are in the form of simple dorsal and ventral sheets, separable towards the base of the fin into superficial and deep layers, both are inserted into the horny fin-rays. The transition from trunk- to limb-muscles is well shown.

Humphry, Jour. Anat. & Physiol., vol. vi. 1872, p. 271.

- C. 123. Longitudinal section through the left pectoral fin of a Dog-fish (*Scyllium catulus*), showing the arrangement of deep (basio-radial) and superficial layers of muscle on either surface of the fin.

- C. 124. Right pectoral fin of a Sea-Cat (*Chimæra monstrosa*). The muscles in connection with the shoulder-girdle are more numerous and show greater individuality than in the Dog-fish. Those proper to the fin are still comparatively simple—the superficial and deep layers being clearly defined only on the ventral aspect. Upon the dorsal surface the general muscle-mass, owing to the normally rotated position of the fin, is so folded upon itself that its posterior part runs diagonally from the base of the scapula to the posterior margin of

the fin, and is thus able to produce the rotary movements so important in swimming. The fin as a whole can be protracted and retracted by the latero-scapularis and coracobasalis.

C. 125. Right pectoral fin of a Cod (*Gadus morrhua*), showing the muscles. Deep and superficial layers can be recognized on both surfaces of the fin, in the form of well-defined muscles which cross one another at an acute angle. A small muscle (dilator) is situated along the anterior border of the fin and inserted on the base of the anterior fin-ray.

C. 126. Right pectoral fin of *Periophthalmus koelreuteri*. The muscles upon the dorsal (inner) surface of the fin are greatly developed, probably in connection with the land-walking habits of the fish—and extend for a considerable distance down the fin-rays.

Hämmerle, Bericht. d. Naturforsch. Gesell. Freiburg, Bd. x. 1897, p. 20.

C. 127. Fore limbs of a Hell-bender (*Cryptobranchus alleganiensis*), showing in the upper specimen the superficial, and in the lower the deep muscles. As in other Urodeles the limb movements are of a very generalized nature without any great precision. The muscles are accordingly simple in their arrangement and mostly have the form of broad sheets. The coraco-brachial muscles are strongly developed, as in the Reptiles, but as yet there is no representative of the biceps unless perhaps the coraco-radialis proprius may be so regarded. The dorso-humeralis gives origin to a very large and extensive dorso-epitrochlearis (anconeus scapulæ medius), and is itself in part continued to the humerus upon the outer surface of the arm—a course that suggests the condition of the latero-scapularis in the Dog-fish. The superficial extensor and flexor sheets of the fore-arm are each divided into three segments. The median of these is attached to the fingers, and the lateral to the radius and ulna respectively. The deep layer is chiefly confined to the hand and distal part of the fore-arm. The following is a list of the muscles,

indicated by numbers and capital letters. 1. Capiti dorso-scapularis. 2. Basi-scapularis. 3. Thoraci-scapularis. 4. Pectori scapularis internus. 5. Pectoralis. 6. Supracoracoideus, similar to the supracoracoideus of Reptiles, Birds, and Monotremes. 7. Coraco-brachialis longus. 7*. Coraco-brachialis brevis. Attached to the inner border of the coraco-brachialis longus is a fine tendon—coraco-radialis proprius—which is considered by some to represent the biceps, but is more likely a purely Amphibian muscle. 8. Humero-antebrachialis inferior. 9. Procoraco-humeralis. 10. Dorso-humeralis. 11. Dorsalis scapulæ. 12. Anconeus. A. Humero-radialis volaris. B. Humero-phalangei volares II–V. C. Humero-ulnaris volaris. The distal fibres of this muscle are continued along the border of the little finger and form an abductor minimi digiti (humero-metacarpus v. dig. volaris). D. Ulnari-metacarpi volares. E. Humero-radialis dorsalis. F. Humero-digiti II–V. dorsalis. G. Humero-ulnaris dorsalis. H. Ulnari-phalanx II. dorsalis. I. Carpo-phalangei. Between the toes are well-developed interossei.

Mivart, Proc. Zool. Soc. 1869, p. 264.

- C. 128. Left fore-limb of a Bull-Frog (*Rana catesbiana*), showing that the tendon of the anconeus is thickened as it passes over the elbow-joint; that it plays on a convexity at the lower and back part of the humerus, and acts as a substitute for the olecranon. O. C. 276 B.
- C. 129. Left fore-limb of a Surinam Toad (*Pipa americana*), showing a sesamoid bone interposed like a patella between the tendon of the anconeus and the elbow-joint. O. C. 276 c.
- C. 130. Left fore-limb of a Lizard (*Varanus salvator*), showing the superficial muscles. The muscles, as might be expected from the active and accurate movements of the limbs, are far more numerous and specialized than in the Urodele; they are in most cases powerful, but show no special concentration of strength in any particular region of the limb. The following may be noted:—The supracoracoideus; a

muscle that in the ascending series is last met with in the Monotremes (see No. C. 139). Coraco-antebrachialis (biceps): both heads rise from the coracoid and unite near their insertion; the outer one is digastric, with a central tendon where the muscle crosses the shoulder-joint; the muscle is inserted, as in many lower mammals, into both ulna and radius. The coraco-brachialis: divided into two parts, both of great size. The humero-antebrachialis inferior unites with the coraco-antebrachialis before its insertion. The anconeus rises by four heads, respectively scapular, coracoidal, and humeral (two) in their origin; the coracoid head is to a large extent represented by tendon. The carpo-digitalis ventralis brevis (flexor sublimis digitorum) is entirely confined to the hand and takes origin from the annular ligament. The teres major is absent. O. C. 64 y t.

- C. 131.** Right fore-limb of a Lizard (*Varanus salvator*), showing the deeper muscles. An accessory pronator (ulno-carpalis) is present, crossing the arm from the inner and anterior surface of the internal condyle to the radius above the insertion of the epitrochleo-radialis (pronator teres); it probably forms part of the ulno-radialis (pronator quadratus). O. C. 64 y u.

Fürbringer, Morph. Jahrb., Bd. i. 1876, p. 688; Mivart, Proc. Zool. Soc. 1867, p. 775.

- C. 132.** The nerves and superficial muscles of the right fore-limb of a Crocodile (*Crocodilus acutus*). While the musculature in general is weaker than that of the Lizard, there is a marked preponderance in strength of the muscles of the shoulder and upper arm over those of the fore-arm. The muscles most developed are those concerned in the dorso-ventral movements of the shoulder (dorsalis scapulæ [deltoid] and pectoralis) and in the extension of the elbow (anconeus), movements of considerable importance to the Crocodile in balancing and steering through the water. The following comparisons may be made with *Varanus*:—The dorsalis scapulæ (deltoid) is double. The coraco-antebrachialis (biceps) has only one head. The coraco-brachialis longus is absent. Between the humero-ante-

brachialis inferior (brachialis anticus) and outer humeral head of the anconeus is a muscle (humero-radialis) that passes from the lateral tubercle of the humerus to the radius; it probably represents part of the deltoid. The humero-radialis lateralis (flexor carpi ulnaris) is single. The carpo-digitalis ventralis brevis is confined to the hand. O. C. 63 E.

- C. 133. The nerves and deep muscles of the left fore-limb of a Crocodile (*Crocodilus acutus*). There is no ulno-carpalis (accessory pronator). The teres major is well developed. O. C. 63 F.

Fürbringer, Morph. Jahrb., Bd. i. 1876, p. 767.

- C. 134. Part of the sternum, shoulder-girdle, and left wing of a King Vulture (*Cathartes papa*), showing the muscles. The pectoralis is separable into two distinct portions. The larger of the two (mostly removed in the specimen) is superficial in position; it rises from the posterior part of the body of the sternum, the border of the sternal keel, and the clavicle, and is attached to the radial crest of the humerus. The second part (which has been slightly raised to show the supracoracoideus beneath it) rises from the sternal keel and clavicle beneath the first, its fibres rapidly converge to a narrow flat tendon which is attached to the humerus distal to the first part. The pars extensor secundariorum of the metapatagealis is well marked: this muscle, situated beneath the skin of the elbow, spreads the proximal secondaries; it is remarkable for the length and delicacy of its tendon of origin. The deltoid extends little more than halfway down the humerus. O. C. 64 y h.

- C. 135. Right wing and half the trunk of a Rook (*Trypanocorax frugilegus*), showing the muscles. During flight the wing is mainly moved as a whole from the shoulder; its primary movements are depression and elevation, constituting respectively the essential parts of the stroke and recovery. The down stroke is produced by the pectoralis major, a muscle that occupies the greater part of the cavity between the surface and keel of the sternum; elevation is due to a

smaller muscle (supracoracoideus) that arises from the sternum beneath the pectoralis major, passes as a tendon over the point of the shoulder to its dorsal surface in a canal formed by the union of the three bones of the shoulder-girdle, and is finally attached to the humerus proximal to the radial crest. The recovery is also probably to a great extent assisted by the pressure of air due to the momentum of the bird. During the down stroke the wing is usually fully extended, but in the recovery the wrist and elbow are flexed, the patagium at the same time being contracted by the propatagealis and a system of elastic ligaments in connection with it. The wing is also capable of extensive rotation at the shoulder, whereby the angle made by its surface to the horizon can be adapted with great nicety to the most varying conditions. The tendons of the fore-arm and hand are remarkably long and slender, while all the heavier and more important muscles are concentrated upon the body or near the shoulder. By this means the wing is rendered light and manageable, and at the same time the centre of gravity of the bird is lowered. Note should be taken of the muscles of the hand, which are quite rudimentary, and of the propatagealis muscles. The latter are represented by two muscular slips that rise together from the dorsal end of the clavicle and are inserted by long tendons into the wrist, extensor metacarpi ulnaris, and the surface of the patagium; the tendon of the anterior of the two muscles consists mainly of elastic tissue. Somewhat analogous patagial muscles are found in certain flying mammals. O. C. 64 Y o.

Presented by St. George Mivart, Esq.

Shufeldt, *Myology of the Raven* (London, 1890), p. 66.

- C. 136.** Right wing of a Rook (*Trypanocorax frugilegus*), showing the deep muscles. Attention is drawn to the following:—The biceps, a single muscle, rising by two tendinous heads from the coracoid and humerus respectively; it is inserted on the ulna. The deltoid is double and attached to the outer surface of the humerus as far as the external condyle. The entepicondylo-radiales: two powerful pronators of the fore-arm. The supinator (ectepicondylo-radialis) is

weak. The extensor metacarpi radialis is so attached to the humerus and base of the thumb that upon extension of the elbow it is tightened, and is capable, without any contraction of its own, of fully extending the hand. O. C. 64 γ *p*. Presented by St. George Mivart, Esq.

- C. 137. Right shoulder of a Rook (*Trypanocorax frugilegus*), showing in more detail than in the previous specimens the levator (supracoracoideus) and rotator muscles of the humerus. A green rod has been placed beneath the supracoracoideus to show its tendon entering the canal between the bones of the shoulder-girdle. The distal part of its tendon can be seen below the deltoideus minor. O. C. 64 γ *q*.

P Presented by St. George Mivart, Esq.

- C. 138. Right wing of a Wild Duck (*Anas boschas*) from which the skin of the ventral surface has been removed to show two elastic ligaments. The most important of these (indicated by black paper) is situated along the free border of the propatagium, and represents in a modified form the tendon of the propatagealis muscle. The elastic tissue appears abruptly in the tendon 10 mm. from the muscle, and is attached partly to the distal end of the radius, partly by means of a long inelastic tendon to the base of the thumb. In action it tends to flex the elbow during the recovery, and at the same time tightens the patagium. The other elastic ligament runs along the ulnar margin of the wing and is attached to the quill of each of the remiges; at the elbow it passes into a diffuse layer of subdermal elastic tissue connected with the metapatagealis muscle. In this ligament the elastic tissue is mainly present between the feathers, which are by its means drawn together when the arm is flexed.

Fürbringer, Anatomie der Vögel, 1888, p. 583.

- C. 139. Right fore-limb of a Spiny Anteater (*Tachyglossus* [*Echidna*] *aculeata*), showing the superficial muscles. This limb, both in its musculature and general features, affords an excellent example of the peculiarities associated with digging habits. It is remarkably short and thick-set, and, while all

the muscles are well developed, those brought into play during the backward scratching movements (*latissimus dorsi*, *extensor antebrachii*, *flexor digitorum*) are exceptionally powerful. Apart from the intrinsic strength of these muscles, the efficiency of the *latissimus dorsi* is largely increased by its direct insertion upon the internal condyle of the humerus. The large size of the pronator teres, in comparison with the supinators, may perhaps be accounted for by another digging movement, *i. e.* the turning outwards of the palm of the hand to throw the dirt clear of the body. Besides these features connected specially with the action of the limb, the following muscles are of great interest owing to their strongly reptilian characters:—The *supracoracoideus* (found among mammals only in the Monotremes). The biceps with no scapular origin. The coraco-brachialis longus and brevis, two large muscles with striking reptilian features (No. C. 130). The *extensor carpi radialis longior* inserted upon the scapho-lunar (the usual reptilian insertion). Attention is also drawn to the following peculiarities:—The *latissimus dorsi* is double, one head originating from the dorsal vertebræ (cut short in the specimen), the other from the posterior angle of the scapula. Owing to the outward rotation of the anterior border of the scapula, the origin of the *supraspinatus* has been shifted to its ventral surface and that of the *subscapularis* to the dorsal. There is a distinct *epicoraco-brachialis*. The *flexor digitorum* (probably answering to both *flexor sublimis* and *profundus*) forms a single fleshy mass from which at the wrist five stout tendons are given off to the fingers. The *palmaris longus* is absent. O. C. 64 z.

C. 140. The deep muscles of the left fore-limb of a Spiny Ant-eater (*Tachyglossus* [*Echidna*] *aculeata*). O. C. 64 z a.

Westling, Bihang Svenska Vet.-Akad. Handlingar, Stockholm, Bd. xv. 1889, p. 12.

C. 141. The right fore-limb of a Duck-billed Platypus (*Ornithorhynchus anatinus*), showing more especially the muscles of the fore-arm and hand. In the main they agree with those of *Echidna*. The insertion of the pronator teres is, however, to the middle of the radius, and there is a distinct

though small flexor sublimis. It is confined entirely to the hand, as in reptiles, and consists of four small bellies that rise at the level of the wrist from the common deep flexor tendon, and are inserted lower down into the sheaths of the four inner deep tendons.

Coues, Commun. Essex Inst., vol. vi. 1871, p. 151.

C. 142. Superficial muscles of the right fore-limb of a Wallaby (*Macropus ruficollis*). The musculature, in conformity with the somewhat rudimentary nature of the limb, is of a very feeble description, especially in the fore-arm and hand. The most powerful group of muscles are the extensors of the elbow. The following features are of interest:—The deltoid is single. There is a very strong connection (“achselbogen”) between the latissimus dorsi and pectoralis, indicating the original continuity of these muscles (see No. C. 122). The coraco-brachialis brevis, as in all Kangaroos, is alone present. The biceps originates by a single head from the coracoid, passes superficial to the shoulder-joint, and divides during the latter part of its course into two distinct bellies, attached respectively to ulna and radius. The supinator longus is attached to the carpus. O. C. 64 z d.

C. 143. Left fore-limb of a Wallaby (*Macropus ruficollis*) showing the deeper muscles. The flexor sublimis rises about the middle of the forearm from the surface of the flexor profundus. O. C. 64 z e.

Parsons, Jour. Anat. & Physiol., vol. xxxii. 1898, p. 125.

C. 144. Left fore-limb of a Koala (*Phascolarctus cinereus*), showing the coraco-brachialis, brachialis internus, and biceps muscles. All three varieties (longus, medius, and brevis) of the coraco-brachialis are present. The insertion of the medius and longus occupies the entire distal half of the inner side of the humerus. The coraco-radial and glenoulnar portions of the biceps, as in many Marsupials, are quite separate from one another; the tendon of the long head lies outside the capsule of the shoulder-joint. O. C. 64 z k a.

Presented by Prof. G. B. Howes.

C. 145. Muscles and nerves of the right fore-limb of a Great Anteater (*Myrmecophaga jubata*). The limb is mainly used for digging, and is remarkable for the great size and strength of the extensors of the elbow and of the flexor digitorum. The latter muscle, in particular, is enormous and nearly equals in bulk all the rest of the fore-arm muscles put together. It will be noticed that there is no indication of specially powerful movements of the shoulder such as are found in *Echidna* (No. C. 139), and probably a larger share of the work is done by the flexion of the fingers. The following peculiarities should be noted:—The extensor antebrachii is assisted in its action by a very powerful dorso-epitrochlearis on the inner side of the arm. The subscapularis is intersected by ten tendinous planes, and is perforated by the short head of the biceps (in the Sloth the subscapularis is completely double.) The biceps is inserted both into the radius and (in conjunction with the brachialis internus) into the ulna. The epitrochleo-anconeus, as in most other Edentates, is remarkably powerful. The supinator longus is divided into two parts, one of which has the usual characters, the other is inserted into the fascia covering the flexor surface of the fore-arm. The extensor carpi radialis longus is absent. The flexor carpi ulnaris is double. O. C. 64 z k c.

Pouchet, Mémoires sur le Grand Fourmilier, 1867, p. 5 ;
 Windle & Parsons, Proc. Zool. Soc. 1899, p. 314.

C. 146. The right fore-limb of a Three-toed Sloth (*Bradypus tridactylus*), showing the muscles. In this Edentate, which spends its life suspended by its hook-like claws from the branches of trees, the extensor muscles are feebly developed throughout the arm, but the pectoral muscles and flexors are very powerful. The biceps is remarkable. It consists of three parts:—(1) A long ribbon-like strip arising from the region of the coracoid in close connection with the deltoid and inserted partly into biceps III. and partly into the fascia on the flexor surface of the fore arm; it passes superficial to the pectoralis major. (2) The long head arises by tendon from the base of the coracoid, perforates the origin of biceps III., and is inserted into the

ulna. (3) The short head arises from the humerus on a level with the pectoralis insertion, and is inserted on the radius. The flexion of the elbow is probably to a great extent helped by the supinator longus and pronator teres. The former muscle is in two parts, and arises from the whole length of the humerus distal to the deltoid. The flexor digitorum has a common belly which gives off a powerful tendon to each of the digits.

Windle & Parsons, Proc. Zool. Soc. 1899, p. 314.

- C. 147. Muscles of the left fore-limb of a Manatee (*Trichechus manatus*). Locomotion is entirely due to the powerful spatulate tail, the fore-limbs being mainly used for balancing and steering, and also to a limited extent for clasping the seaweed when browsing. The muscles, besides showing many peculiarities in detail, are remarkable for the great development of those connected with the fingers. In consequence the hand has greater freedom of movement than its external appearance would suggest, and affords in this particular a striking contrast to the flipper of the Cetacea. The following muscles should be noticed:—The cephalohumeral (cleido-occipitalis), originating from the occiput and inserted on the humerus between the deltoid and pectoralis major (its insertion only is shown). The biceps is in a much reduced condition; it consists of two separate heads—one of fair size rising from the coracoid and inserted halfway down the inner side of the humerus, and a smaller long head rising from the glenoid border and inserted partly upon the humerus near the short-head insertion, and partly by a fine tendon upon the radius. The brachialis internus is of great size, and seems to have more or less usurped the function of the biceps. The tendons of the extensor digitorum communis branch out at the wrist at a wide angle, and when in action would strongly adduct the digits. The supinator longus is attached to the carpus (a common insertion among Marsupials). Only one extensor carpi radialis is present. The pronator teres is fused with the flexor carpi radialis. This composite muscle and the flexor sublimis pass very obliquely across the forearm, and doubtless have a strong pronating action. The

triangular space between the ulna and the outer side of the little finger is occupied by a large muscular sheet (flexor carpi ulnaris ?) which forms a powerful abductor minimi digiti. The interossei are remarkably developed. The following muscles are absent: teres minor, coraco-brachialis, supinator brevis. O. C. 281 E.

Presented by the Directors of the Brighton Aquarium.
Murie, Trans. Zool. Soc., vol. viii. 1874, p. 156.

- C. 148.** Superficial muscles of the right fore-limb of a foetal African Elephant (*Elephas africanus*). The muscles are all of a distinctly massive type, and being for the most part fleshy close down to their insertions, form a stout supporting and stiffening investment to the limb-skeleton. A strong ligamentous band (partly elastic) covers the extensor lateralis, and elastic tissue is associated with the flexor carpi radialis. The following special features deserve notice:—The tendon of the latissimus dorsi is double, and embraces that of the teres major. The dorso-epitrochlearis rises to a great extent from the posterior angle of the scapula. The biceps is represented only by the long head. The pronator teres is rudimentary. The supinator longus is attached to the carpus. O. C. 64 x a.

- C. 149.** Left fore-limb of a foetal African Elephant (*Elephas africanus*), showing the deeper muscles, especially those of the fore-arm. O. C. 64 x b.

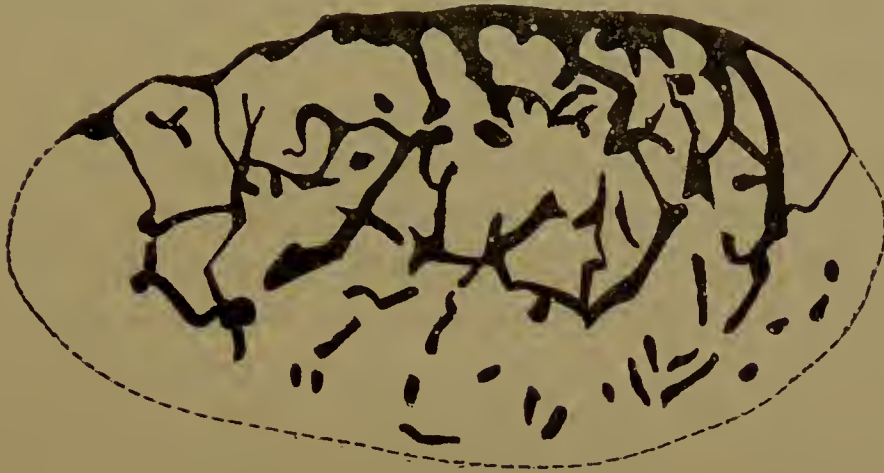
Miall & Greenwood, Jour. Anat. & Phys., vol. xii. 1878, p. 264.

- C. 150.** Two transverse sections through the proximal part of a muscle (flexor carpi radialis?) from the fore-limb of an Indian Elephant (*Elephas indicus*), showing a remarkable development of elastic tissue in the perimysium. The elastic tissue forms a stout layer upon the outer surface of the muscle, occupying a quarter of the circumference and connected to a variable extent with a series of elastic sheets and strands that pass between the muscle-bundles. (Fig. 5.)

Presented by Lord George Sanger, Esq.

- C. 151. The remainder of the same muscle. Part of its deep surface has been dissected away to show the arrangement of the elastic tissue between the muscle bundles in sheets

Fig. 5.



The cut ends of the elastic bundles, represented black.

$\frac{1}{2}$ nat. size.

of variable thickness ; the stoutest of these, in which the fibres are approximately parallel to the long axis of the fasciculi, lie in the interspace where several fasciculi meet ; they are connected by thinner sheets in which the fibres take a course diagonal to the fasciculi. Towards the distal end of the muscle the elastic sheets have a more ribbon-like character and are inserted upon the inner surface of the tendon. Upon the reverse aspect of the specimen the superficial layer of elastic tissue is shown ; halfway down the muscle it abruptly assumes the structure of an ordinary tendon. This great development of elastic tissue in the flexor of the wrist is doubtless connected with the weight of the animal, and probably both assists in the elastic support of the normally over-extended foot and diminishes the risk of rupture of the muscle or tendon under the sudden strain thrown upon them during rapid locomotion. *Presented by Lord George Sanger, Esq.*

- C. 152. Right fore-foot of a Horse (*Equus caballus*), showing the intrinsic muscles and tendon attachments. Owing to the excessive reduction in the number of digits, the intrinsic muscles are few. Two lumbricals are present (in

the specimen most of the inner one has been removed), originating from the sides of the deep flexor tendon and inserted into the fetlock. The interossei of the splint-bones are rudimentary and lie between them and the metacarpal, while the short flexor of III. dig. has been transformed into the great posterior suspensory ligament of the fetlock. O. C. 284 M.

- C. 153.** Right fore-limb of a Calf (*Bos taurus*), showing the superficial muscles. The reduction in number of the digits and the acute angles at which the several bones meet indicate that the limb is suitable for rapid movement. The muscles, with the exception of the extensor antebrachii, are of slender build, but occasionally (*e.g.* teres major, brachialis internus) gain considerable extra power by their insertion at a distance from the joint. As in the bird's wing (C. 135) the limb is rendered light and mobile by the concentration of the weight towards the proximal end, the distal tendons being of great length. Increased rigidity of the elbow-joint is gained by the loss of all movements of pronation and supination; in consequence, pronators and supinators are absent. The following details are of special interest:—The biceps is represented by the long head only, the tendon of origin lies outside the capsule of the shoulder-joint, its insertion is upon the radius. The extensor digitorum communis is double; the tendon of the inner head is attached to III. dig., that of the outer to III. dig. and IV. dig. The extensor carpi ulnaris is fused at its insertion with the flexor carpi ulnaris. In front of the flexor carpi radialis there is a fibrous band, which probably represents the pronator teres. O. C. 64 x e.

Presented by Colonel Burgess.

- C. 154.** Left fore-limb of a Calf (*Bos taurus*), showing the deep muscles. On the extensor surface a small slip is shown which, rising from the ulna, passes over the extensor pollicis and unites with the extensor communis. The flexor profundus rises by three very distinct heads from the humerus, olecranon, and radius respectively. There are no lumbricals. O. C. 64 x f.

Presented by Colonel Burgess.

C. 155. Right fore-limb of a Seal (*Phoca vitulina*), showing the superficial muscles. The adaptation of the limb to a swimming life is shown in its musculature by the high development of the rotator muscles, especially those of pronation. During the backward stroke the palmar surface of the hand is turned outwards by the action of the usual pronator muscles assisted by some of the flexors (flexor carpi ulnaris, palmaris longus) which run from the point of the elbow towards the radial margin of the hand. At the same time the digits are spread by an abductor minimi digiti arising from the elbow, and inserted in the subcutaneous tissue on the outer side of the little finger. Supination takes place during the recovery, whereby the narrow anterior border of the limb is turned to the front and offers the minimum of resistance to the water. In this action the usual supinators are assisted by the extensor pollicis brevis and extensor ossis metacarpi pollicis. The following muscles show exceptional features:—A fasciculus of the extensor antebrachii (marked * in the specimen) rising from the vertebral end of the scapula posterior to the spine and inserted partly into the elbow, partly into the abductor minimi digiti (it is sometimes called dorso-epitrochlearis, but this name seems better applicable to a tendinous strand running from the latissimus dorsi to the internal condyle). The latissimus dorsi is in two parts—one inserted into the teres major, the other into the outer bicipital ridge with the pectoralis major. The extensor digitorum communis is double.

C. 156. Left fore-limb of a Seal (*Phoca vitulina*), showing the deep muscles. There is a small subscapularis accessorius, which rises from the posterior border of the scapula near the glenoid and is inserted into the joint-capsule and upper part of the humerus.

Miller, Challenger Reports, Zool. vol. xxvi. 1888, p. 142 ;
 Lucæ, Abhandl. Senckenberg. Naturf. Gesellsch.,
 Bd. ix. 1873–75, p. 474.

C. 157. Right humerus and part of the fore-arm of a Dog (*Canis familiaris*), showing the brachialis internus. The muscle is

of large size ; it has a usual but generalized mammalian origin from the posterior and outer surfaces of the proximal half of the humerus and winds spirally around that bone. It joins the tendon of the biceps at its distal end, and is inserted with it by a bifurcated tendon upon both ulna and radius. O. C. 64 z q a. *Presented by Prof. McFadyean.*

Ellenberger & Baum, Anatomie des Hundes (Berlin, 1891), p. 198.

- C. 158.** Radius and ulna of a Dog (*Canis familiaris*), with the rotator museles. The pronator quadratus is very strongly developed, and occupies nearly the whole of the interosseous space. The upper part is possibly a precursor of the deep portion of the pronator teres. The biceps is attached to both ulna and radius. *Presented by Prof. McFadyean.*
Macalister, Jour. Anat. and Physiol., vol. ii. 1868, p. 8.

- C. 159.** Left hand and part of the fore-arm of a Spider Monkey (*Ateles* sp.). The suppression of the thumb gives rise to a hook-like prehensile hand somewhat similar to that of the Sloth, but far more mobile. The tendon of the extensor metacarpi pollicis is of exceptional strength, and acts upon the hand, as a whole, through the mediation of the thumb-rudiment. The other long extensors of the thumb are absent. The thumb-attachment of the first interosseous muscle is retained. A blue rod is placed beneath the tendon of the extensor ossis metacarpi pollicis, and a green rod between the thumb-rudiment and the index. O. C. 64 m b a.

Leehe, Bronn's Thier-reihe, Bd. vi. (Mammalia), 1897, p. 843.

- C. 160.** Left arm of a Baboon (*Papio* [*Cynocephalus*] *babuin*), showing the chief muscles*. In this ape, which in its locomotion is to a great extent quadrupedal, the museles in general are powerful and, when compared with those of

* In dealing with the Old World Apes great assistance has been derived from an unpublished work on Catarrhine Myology, kindly lent by the author, Dr. Arthur Keith.

monkeys whose arms are mainly used for prehension, show a marked development of the extensor antebrachii group. The following features are of interest, particularly in their relation to the Anthropomorpha:—The latissimus dorsi is united with the teres major before its insertion. The dorso-epitrochlearis is large. A coraco-brachialis brevis is present (a fairly constant muscle in Cynomorpha, but usually absent in Anthropomorpha). The three parts of the deltoid are very distinct, leaving a considerable gap between the acromial and spinal portions. The epitrochleo-anconeus is well-developed. Palmaris longus fairly strong. There is no extensor pollicis brevis. O. C. 64 D.

Champneys, Jour. Anat. & Physiol., vol. vi. 1871, p. 178.

- C. 161.** Right fore-limb of a Crested Baboon (*Cynopithecus niger*), showing the dorso-epitrochlearis, coraco-brachialis (brevis and medius), and brachialis internus muscles. O. C. 64 M b d.

- C. 162.** Right fore-limb of *Macacus maurus* showing the muscles. As a whole they do not display the powerful development of the Baboon (C. 160), but in their details the two limbs are closely similar. In addition to the features pointed out in connection with the Baboon, it may be noted that the deltoid is not separated into its three divisions and the pronator teres is inserted somewhat lower down the radius. Blue rods have been placed beneath the coraco-brachialis brevis, extensor profundus, and the extensor digitorum lateralis. The latter sends tendons to both iv. dig. and v. dig. (this is general in Orangs, Gibbons, and Cynomorpha). O. C. 64 M a. *Presented by J. Abrahams, Esq.*
Haughton, Proc. Irish Acad., vol. ix. 1867, p. 283.

- C. 163.** Right arm and half the chest-wall of a Gibbon (*Hylobates leuciscus*), showing the superficial muscles. In this essentially arboreal anthropoid, the flexors of the elbow greatly exceed the extensors in size and strength, but the disproportion is not carried to the fore-arm as in the Sloth (C. 146). The following details are noteworthy in comparison with other Anthropoids. The deltoid extends more than halfway down the humerus. The supinator

longus is attached very high up on the radius. The pronator and supinator muscles are weak, as well as all the muscles belonging to digit v. There is no extensor pollicis brevis. O. C. 64 M i.

For the Anthropoids: Hepburn, Jour. Anat. & Physiol., vol. xxvi. 1891-92, p. 149.

- C. 164. Left arm of a Gibbon (*Hylobates leuciscus*), showing the deep muscles. The pectoralis minor is attached to clavicle and coracoid process. The latissimus dorsi (as in the other Anthropoids with exception of the Gorilla) is united to the teres major before its insertion. The dorso-epitrochlearis is short and broad; its fibres run diagonally to the inter-muscular septum, and are attached to it between the proximal two-thirds. The short head of the biceps arises from the coracoid, and from nearly the whole length of the humerus; most of its fibres join the long head, but those that rise nearest the elbow run directly to the surface of the supinator longus. There is a flexor longus pollicis. O. C. 64 M m.

Keith, Nat. Sci., vol. ix. 1896, p. 373.

- C. 165. Right arm of an Orang-Outang (*Simia satyrus*) and lower part of the left arm, showing respectively the superficial and deep muscles. The pectoralis major has a slight origin from the clavicle. The pectoralis minor is attached to the coracoid and scapular end of the clavicle. The dorso-epitrochlearis is of medium development. There is no coraco-brachialis brevis. The two heads of the biceps are separate through their whole extent (a fairly common variation in the Orang); both are inserted on the radius; there is no fascial insertion. Pronator teres and supinator longus are both inserted higher up the radius than in Man. There is no tendon from the flexor profundus to the thumb. Extensor pollicis brevis is present as a subdivision of the extensor ossis metacarpi pollicis. The pronator quadratus is very weak. Extensor lateralis (ext. min. dig.) supplies iv. dig. & v. dig. O. C. 64 M d.

Presented by C. Dent, Esq.

- C. 166. Distal part of the right arm of an Orang-Outang (*Simia satyrus*), in which the deep flexors and lumbricals are more

clearly shown than in the last specimen. Between the tendons to III. & IV. there is a fine tendon, inserted partly into tendons III. & IV. and partly into the lumbrical.

O. C. 64 M *d a.* Presented by Victor Horsley, Esq.

Keith, Nat. Sci., ix. 1896, p. 317.

- C. 167. Right arm and half the chest-wall of a Gorilla (*Anthropopithecus gorilla*), showing the superficial muscles. The pectoralis major has a large clavicular origin ; its two parts are separated from each other and from the deltoid by considerable gaps. The epitrochleo-anconeus is fibrous. The flexor carpi radialis has an extensive origin from the oblique line of the radius. The palmaris longus is absent. An extensor pollicis brevis is present. O. C. 64 N *a.*

- C. 168. Deep muscles and arteries of the left arm of a Gorilla (*Anthropopithecus gorilla*). The pectoralis minor is attached to the coracoid process in common with the short head of the biceps. The teres major and latissimus dorsi are separately attached to the humerus. Coraco-brachialis brevis is absent. The dorso-epitrochlearis is almost rudimentary ; it joins the extensor antebrachii. The extensores carpi radialis longus and brevis are separate from their origin. O. C. 64 N *b.*

Keith, Nat. Sci., ix. 1896, p. 28.

- C. 169. Superficial muscles of the right fore-limb of a Chimpanzee (*Anthropopithecus troglodytes*). The three parts of the deltoid are readily separable from one another. The dorso-epitrochlearis is tendinous for its distal third and extends down to the inner condyle. The coraco-brachialis is remarkable ; it is represented by medius and longus : the longus arises from the inner surface of the short head of the biceps, and has a double insertion, (1) by several fibres into the anterior border of the dorso-epitrochlearis, and (2) into the inter-muscular septum between brachialis internus and extensor antebrachii near the internal condyle. The supinator longus has a two-fold origin from the outer side of the humerus ; the two heads unite about the middle of the fore-arm ; their common tendon is attached close above the styloid process of the radius. The extensor carpi ulnaris gives off a small slip to the annular ligament.

The two portions of the adductor pollicis (transversus and obliquus) are entirely distinct.

Presented by John Marshall, Esq.

C. 170. Left fore-limb of the same Chimpanzee, showing the nerves and deep muscles. The pectoralis minor is attached to the head of the humerus. The coraco-brachialis is represented by the medius, perforated by the musculo-cutaneous nerve. The flexor carpi radialis has a supplementary tendon of attachment to the trapezium (indicated by a black bristle). The radial segment of the flexor profundus supplies the index and gives off a small muscular slip and tendon (flexor longus pollicis) to the thumb. The fourth lumbrical has a double origin from tendons IV. & V. of the flexor profundus. *Presented by John Marshall, Esq.*

C. 171. Left elbow of a Chimpanzee (*Anthropopithecus troglodytes*), showing the supinator brevis. The muscle is broken up into several laminæ, distinguishable mainly from the different course of their muscle-fibres, and is overlaid by a remarkable sheet of muscle (indicated by a blue rod) that rises from the outer side of the humerus close above the condyle beneath the extensor carpi radialis, and is inserted into the radius with the distal part of the underlying supinator brevis.

C. 172. Deep muscles of the left hand and distal part of the arm of a Chimpanzee (*Anthropopithecus troglodytes*). The rudimentary tendon that represents the flexor longus pollicis rises from the sheath of the flexor profundus tendon II. Besides the usual three adductor palmar interossei, there are also upon this surface of the hand four abductor interossei attached to the sides of the first phalanges of digits II., III., IV. (blue rods are placed beneath their tendons). These muscles are probably not true palmar interossei, but slips from the dorsal interossei that have migrated to the palmar surface. Each of the extensors of the thumb is inserted one bone above its usual human attachment.

Hepburn, Trans. R. Soc. Edinburgh, vol. xxxviii. 1897, p. 557 ; Keith, Nat. Sci., vol. ix. 1896, p. 251.

Hind-limb.

- C. 173.** The muscles of the right pelvic fin of a Dog-fish (*Scyllium catulus*). The deep and superficial muscle-layers on both surfaces of the fin are inserted into the horny fin-rays. On the ventral surface they are only recognizable as distinct layers by the different direction of their fibres. Those of the superficial sheet rise from the pelvis and median tendinous septum and run directly to the rays; while those of the deeper layer are interrupted in their course by the basal pterygia. On the dorsal surface the layers are more distinct; the superficial rises from the general aponeurotic sheath of the trunk, and runs in well-defined bundles to the fin-rays (a deeper slip of this muscle (A) is attached to the base of the clasper). The deep layer rises from the basal pterygia.

Davidoff, Morph. Jahrb., Bd. v. 1879, p. 454.

- C. 174.** Right pelvic fin of a Sea-Cat (*Chimæra monstrosa*), showing the muscles. Upon the ventral surface the layers are simple in character and not very clearly defined, but upon the dorsum the superficial sheet shows marked indications of subdivision into three independent muscles (superf. A, B, C). The anterior part of superf. A, from its position, would act as a protractor of the fin.

Davidoff, Morph. Jahrb., Bd. v. 1879, p. 473.

- C. 175.** Right pelvic fin of a Cod (*Gadus morrhua*), showing the muscles. The superficial layer (*Su*) on both surfaces of the fin is divided into several well marked muscles, which, according to their position, act as dilators, approximators, levators, or depressors. The deep layer (*Pr*) on both surfaces is simple. All the muscles are attached to the base of the fin-rays.

- C. 176.** The hind limbs of a Hell-bender (*Cryptobranchus alleghaniensis*), showing the superficial muscles in the upper specimen, the deep muscles in the lower. The arrangement of the muscles in simple superficial and deep layers is more strongly marked than in the fore-limb; it can best be seen in the muscles on the inner surface of the thigh. The following are the names of the individual muscles (indicated by numbers

and capital letters).—1. Pubo-ischio tibialis : a large sheet that corresponds to the pubo-ischio-tibialis of the Lizard. 2. Caudali pubo-ischio-tibialis ; where this muscle unites with the pubo-ischio-tibialis there is a slight tendinous intersection ; it has been suggested that this may have some relation to the intersection seen in the semitendinosus of Man. 3. Ischio-flexorius. 4. Ischio-caudalis. 5. Pubo-ischio-femoralis externus. 6. Pubo-ischio-femoralis internus. 7. Caudali femoris. 8. Ilio-extensorius, part i. ; this muscle expands into a tendinous sheet over the knee, and is continued as a fine tendon to the distal end of the tibia between the femoro-tibialis (C) and femoro-digiti 1–v. (D). 8.* Ilio-extensorius, part ii. 9. Ilio-femoro-fibularis (iliac head). 9.* Ilio-femoro-fibularis (femoral head) : these two muscles roughly correspond to the biceps. 10. Ilio-femoralis. A. Femoro-fibulæ digiti 1–v. : a muscle that possibly represents gastrocnemius, soleus, plantaris, and flexor brevis digitorum. B. Femoro-fibulæ metatarsi 1., II., III. C. Femoro-tibialis. D. Femoro-digiti 1–v. E. Fibulæ metatarsum II. F. Femoro-fibularis. G. Tarsu-digiti 1–v.

De Man, Niederl. Arch. f. Zool., Bd. ii. 1874–75, p. 61.

- C. 177. Superficial muscles of the right hind-limb of a Lizard (*Varanus salvator*). The simple sheets of muscle seen in the fish, and to a less extent in the Urodele, are here broken up into numerous individual muscles, but traces of their original continuity can be seen in the connexions that occur, both between laterally contiguous muscles and those of different segments of the limb. An excellent example of this continuity is afforded by the gastrocnemius, which passes over the heel as a flat tendon to form the point of origin for the short flexors of the foot. The muscles, owing to their generalized character, cannot be directly compared with those of mammals, but they show many points of resemblance to the Bird, the most noteworthy being the presence of an accessory rectus femoris internus (ambiens), a purely reptilian and avian muscle usually continued over the knee to join one of the flexors of the shank, but here inserted upon the crest of the tibia with the femoro-tibialis.

The following muscles should be noticed :—Pubo-ischio-tibialis, a large powerful muscle probably answering to the mammalian gracilis ; it is absent in Chelonians, Crocodiles, and Birds. The pubi-tibialis, a double muscle, though single in many Lizards ; it is absent in the Crocodile. The two peronei are separate ; in many Lizards they form a single mass. The inner head of the gastrocnemius is tibial in origin and double. O. C. 64 x v.

- C. 178. Left hind-limb of a Lizard (*Varanus salvator*), showing the deep muscles. The connection between the flexor tibialis externus and internus and the second part of the inner head of the gastrocnemius should be noted ; also a curious long slender tendon rising from the lower margin of the caudi-femoralis and inserted upon the tibia in conjunction with the pubi-tibialis. O. C. 64 x w.

Gadow, Morph. Jahrb., Bd. vii. 1882, p. 329.

- C. 179. Left hind-limb of a Crocodile (*Crocodilus acutus*), showing the nerves and superficial muscles. Several that in the Monitor are single are here replaced by two, for instance—ilio-fibularis, caudi-femoralis, ambiens. Several also are entirely absent, notably the large pubi-ischio-tibialis. The first part of the ambiens is strikingly bird-like ; its tendon passes diagonally outwards over the knee and is inserted into the peroneus posterior. More or less intimate connections occur between the superficial muscles in the region of the ankle ; thus, the tibialis anticus joins the extensor longus digitorum, and the peronei unite with one another and with the gastrocnemius. The great size of the caudi-femoralis indicates its importance. It seems to act not only as a retractor of the whole limb, but also to produce the lateral movements of the tail. O. C. 63 g.

- C. 180. Nerves and deep muscles of the right hind-limb of a Crocodile (*Crocodilus acutus*). The flexor tibialis internus is more complex than in the Monitor : two of its divisions unite in a common tendon with the flexor tibialis externus. The tendon is forked and inserted by one end upon the neck of the tibia, and by the other, which runs down the leg parallel

to the inner head of the gastrocnemius, to the plantar fascia. This latter tendinous extension seems to represent the similarly disposed slip of the gastrocnemius of the Monitor. The long tendon of the caudi-femoralis is inserted into the outer head of the gastrocnemius. O. C. 63 H.

Gadow, Morph. Jahrb., Bd. vii. 1882, p. 375.

- C. 181. Portions of tendons from an Ostrich (*Struthio camelus*), showing two passing through a sheath formed by a third, which, intervening between them and the centre of motion, acts as a patella to them. O. C. 274. *Hunterian.*
- C. 182. The parts constituting the tarsal joint of an Ostrich. The flexor tendons of the toes pass through a sheath in the tendo Achillis, which is considerably thickened at that part; and while it securely retains them in their proper situation, removes them further from the centre of motion at that joint, and augments the lever of the moving power. O. C. 275. *Hunterian.*
- C. 183. The tendons and ligaments of the joints of the toes of the Ostrich (*Struthio camelus*). The sheath of the flexor tendons is of extraordinary thickness behind the metatarsophalangeal joint. O. C. 275 B.
- C. 184. A vertical section of the tarso-metatarsal bone and phalanges of the greater toe of an Ostrich (*Struthio camelus*), and of their flexor tendons. Each bone has its proper tendon inserted into it, which forms a sheath for the tendon of the succeeding phalanx: and on the plantar aspect of each joint is situated a ligamentous substance (analogous to those in the human finger), forming part of that joint, and playing on an articular surface in the lower extremity of the superior bone. These act like patellæ, removing the flexor tendons farther from the centres of motion of their respective joints, and forming so many elastic cushions to protect the joints and obviate the effects, by diffusing the forces, of pressure and percussion. O. C. 276. *Hunterian.*
- C. 185. Superficial muscles of the right hind limb of a Rook (*Trypanocorax frugilegus*). Union between the muscles of

the different segments of the limb is not so noticeable as in Reptiles. The only connection of the kind which may perhaps be compared with that between the flexor tibialis externus and gastrocnemius of Reptiles, occurs between the tendinous intersection of the caud-ilio-flexorius and the inner head of the gastrocnemius. The common gastrocnemius tendon (formed by the union of a tibial and two femoral heads) is likewise continued over the heel to the middle of the tarso-metatarsus. Certain muscles of the thigh—ambiens (absent in the Rook), ilio-tibialis, the two portions of the caud-ilio-femoralis, and the two portions of caud-ilio-flexorius—are noteworthy for the approximately constant variations they exhibit in different groups of birds. In a similar way the particular mode of arrangement and connection of the deep plantar tendons has been used for taxonomic purposes. The heel is capped by a large sesamoid cartilage, which, as was seen in the previous specimen of the Ostrich, removes the tendons that pass over it to a suitable distance from the centre of motion. O. C. 64 y r.

Presented by St. George Mivart, Esq.

- C. 186. Right hind-limb of a Rook (*Trypanocorax frugilegus*), showing the deep muscles. The caud-ilio-flexorius is divided near its insertion into two parts by a tendinous intersection. The muscle-fibres on the distal side of the intersection are arranged at an angle to the long axis of the proximal and larger part of the muscle, and are attached to the femur close above the condyle. The ilio-fibularis (biceps), before its insertion upon the fibula, passes through a pulley-like tendinous loop that stretches from the external femoral condyle to the origin of the flexor perforatus iv. By means of this mechanism the power of flexing the shank upon the thigh is greatly enhanced. The long flexors of the foot are very much subdivided. The short extensors are reduced to a curious little extensor hallucis brevis, which rises from the anterior surface of the tarso-metatarsus and passes round the outer surface of the first metatarsus to the dorsal surface of the backwardly directed hallux. O. C. 64 y s.

Presented by St. George Mivart, Esq.

Shufeldt, Myology of the Raven (London, 1890), p. 155.

The following seven specimens are designed to show the arrangement of certain thigh-muscles—ambiens, caud-ilio-femoralis 2 parts (femoro-caudal + accessory femoro-caudal, *Garrod*), caud-ilio-flexorius 2 parts (semitendinosus + accessory semitendinosus, *Garrod*), and ilio-tibialis (tensor fasciæ, *Garrod*), and the branches of the great sciatic nerve.

Garrod, Proc. Zool. Soc. 1873, p. 626.

C. 187. Thigh with the pelvis and upper part of the shank of a Kiwi (*Apteryx mantelli*) (subclass Struthioniformes). In this bird all the muscles in question are present. The iliac part of the caud-ilio-femoralis is, however, peculiar, being perforated by the sciatic nerve—a condition only found in Struthiones and Crypturi. A blue rod is placed beneath the portion of the pars ilio-femoralis posterior to the perforation for the sciatic nerve; a pale blue rod beneath the pars caudi-femoris; and black bristles beneath the tendon of insertion of the ambiens. O. C. 64 y b.

C. 188. A similar specimen of the thigh-muscles of *Pauxi mitu* (suborder Gallinæ, order Gallograllæ, subclass Galliformes). In this bird all the muscles are present. The pars caudi-femoris of the caud-ilio-femoralis is, however, very slender. O. C. 64 y a.

C. 189. Muscles of the thigh of a Great Bustard (*Otis tarda*) (suborder Fulicariæ, order Gallograllæ). The pars caudi-femoris of the caud-ilio-femoralis is absent. O. C. 64 y f.

C. 190. Muscles of the thigh of a Tree-Duck (*Dendrocygna autumnalis*) (subclass Anseriformes). The pars accessorius of the caud-ilio-flexorius is absent. The pars ilio-femoris of the caud-ilio-femoralis is very strongly developed. O. C. 64 y c.

C. 191. Muscles of the thigh of a Buzzard (*Buteo tachardus*) (subclass Falconiformes). All the muscles in question but the ambiens and pars caudi-femoris of the caud-ilio-femoralis are absent. O. C. 64 y d.

- C. 192. Muscles of the thigh of a King Vulture (*Cathartes papa*) (order Pseudogryphii, subclass Coraciiformes). Both parts of the caud-ilio-femoralis are absent. O. C. 64 y g.
- C. 193. Muscles of the thigh of a Hornbill (*Buceros*, sp.) (order Picariæ, subclass Coraciiformes). The ambiens, caud-ilio-femoralis (pars ilio-femoris), and ilio-tibialis are absent. O. C. 64 y e.
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The following specimens show certain variations in the arrangement and mutual connections of the deep plantar tendons which are approximately constant for different taxonomic groups of birds.

Garrod, Proc. Zool. Soc. 1875, p. 330.

- C. 194. Right foot of Roller (*Eurystomus pacificus*): the tendon of the flexor longus hallucis unites with that of the flexor profundus without crossing at the lower end of the tarso-metatarsus. From the common tendinous expansion thus formed, individual tendons are given off to the toes. O. C. 64 y k.
- C. 195. Right foot of a Laughing Jackass (*Dacelo gigas*). The tendon of the flexor longus hallucis fuses near the distal end of the tarso-metatarsus with the outer side of the flexor profundus tendon. The flexor profundus gives off tendons successively from its inner side to I., II., & III. digits. The tendon for IV. arises from the point of union of the flexor longus with the flexor profundus. This arrangement is probably a modified form of that seen in the previous specimen. O. C. 64 y m.
- C. 196. Right foot of a Cuckoo (*Cuculus canorus*). The flexor longus tendon crosses superficial to that of the flexor profundus about the middle of the tarso-metatarsus, and at this point is attached to it by fibrous bands (vincula). The tendon of the flexor longus goes to I.; that of the profundus to II., III., IV. This arrangement is common to many four-toed birds. O. C. 64 y l.

- C. 197. Right foot of a Rook (*Trypanocorax frugilegus*). The tendon of the flexor longus crosses superficial to that of the profundus in the same manner as in the previous specimen, but is not united to it by a vinculum. It goes to I. The profundus tendon divides at the base of the toes into three tendons for II., III., and IV. digits respectively. This arrangement is found in most Passerine birds. O. C. 64 x i.

Presented by P. Sharpe, Esq.

- C. 198. Muscles of the left hind-limb of a Duck-billed Platypus (*Ornithorhynchus anatinus*). The gluteus maximus (of which the origin and insertion only have been preserved) is of great size, and is remarkable for its insertion to the posterior surface of both bones of the shank close above the ankle. The gluteus minimus is much fasciculated and is supplied by both iliac and crural nerves, in this feature (characteristic of the ilio-femoralis of Reptiles and Urodeles) the Monotremes differ from all other Mammals. The gastrocnemius is single—represented only by the inner head; it is joined in the middle of the shank by the soleus (thought by some to be the outer gastrocnemial head with a fibular origin), and the two together form the tendo Achillis. The flexor fibularis in the absence of the flexor tibialis sends tendons to each digit. The flexor brevis rises partly from the common tendon of the fibularis, partly from the calcaneum. The first part supplies II., the calcaneal head IV. & V. The extensor longus digitorum is double. A green rod has been placed beneath the tendons of the extensor longus. A blue rod beneath those of the extensor brevis.

Coues, Communic. Essex Instit., vol. vi. 1871, p. 159.

- C. 199. Distal part of the left hind-limb of a Duck-billed Platypus (*Ornithorhynchus anatinus*), showing the deeper muscles. The short extensors rise entirely from the fibula. They are two in number—i. Extensor brevis V. dig., which probably also potentially includes the peroneus brevis—its tendon bifurcates upon the dorsum of metatarsal V.; one branch, representing the peroneus brevis, is inserted upon the apex of metatarsal V., the other upon the phalanges. ii. Extensor brevis digitorum, rising beneath the preceding

and inserted by a broad tendinous expansion into all the digits. The plantaris is small, and rises from the inner surface of the fibula, it is inserted upon 1. The popliteus (pronator tibiæ) rises from the fibular process and is inserted upon the hinder margin of the tibia.

Ruge, *Morph. Jahrb.*, Bd. iv. 1878, p. 593.

C. 200. Superficial muscles of the left hind-limb of a Spiny Anteater (*Tachyglossus* [*Echidna*] *aculeata*). The limb is excessively muscular (the creature is said to be able with ease to push out of its way stones of 30 lb. weight). The muscles for the retraction of the thigh and flexion of the knee are the groups most strongly developed. The power of flexing the knee in particular is increased by the insertion of the gluteus maximus and biceps in the middle of the shank. The origin of the gluteus maximus is restricted to the posterior sacral and anterior caudal vertebræ—the muscle is separable into three bundles, two inserted into the fibula, the third upon the tibia just distal to the gracilis. There is no tensor fasciæ latæ. The sartorius rises from the pectineal process. The extensor muscles of the digits lie in the same plane and cannot, as in *Ornithorhynchus*, be separated into *extensores longi* and *breves*. O. C. 64 z b.

C. 201. Deep muscles of the right hind-limb of a Spiny Anteater (*Tachyglossus* [*Echidna*] *aculeata*). The rectus femoris agrees with that of *Ornithorhynchus* in having only one head of origin. The plantaris is larger than in *Ornithorhynchus* but similar in other respects. The peroneus brevis is absent. O. C. 64 z c.

Westling, *Bihang Svenska Vet. - Akad. Handlingar*, Stockholm, Bd. xv. 1889, p. 30.

C. 202. Proximal part of the right hind-limb of a Bennett's Wallaby (*Macropus ruficollis*), showing the superficial muscles. The thigh muscles are large and powerful, especially the rectus femoris, vastus externus, femoro-coccygeus, and biceps. The latter muscle is closely connected with the femoro-coccygeus; it has an additional head which rises from some of the anterior caudal vertebræ and

unites with the ischial head and femoro-coccygeus in a common insertion on the anterior surface of the tibia extending from the knee nearly to the ankle. The sartorius, as in other Marsupials, runs directly along the anterior margin of the thigh, and acts as a supplementary extensor cruris. The tensor fasciæ latæ is absent. O. C. 64 z f.

Parsons, Proc. Zool. Soc. 1898, p. 700.

C. 203. Left knee of a Bennett's Wallaby (*Macropus ruficollis*), showing the rotator muscles. They consist of a popliteus and pronator tibiæ. The former rises from the femur, external semilunar cartilage and head of the fibula, and is inserted upon the posterior surface of the proximal end of the tibia. The part that rises from the fibula-head forms a separate slender muscle, parallel to the main portion but quite distinct from it. The pronator tibiæ is confluent with the popliteus and forms a deeper layer of fibres that pass directly between tibia and fibula. O. C. 64 z i.

C. 204. Right hind-foot of a Bennett's Wallaby (*Macropus ruficollis*), showing the long flexor tendons. Owing to the loss of the 1st and reduction of the 2nd and 3rd digits, the tendons of the inner side of the foot are rudimentary. The tendon of the plantaris passes over the heel and near the distal end of the metatarsus divides into two, which supply the 4th and 5th digits. The flexor profundus (represented by the flex. fibularis alone) sends tendons to all four digits. Although the hallux has disappeared, the extensor longus hallucis still exists and sends very fine tendons to digits II. & III. The tendon of the extensor brevis quinti digiti (peroneus quinti) is as large as that of the peroneus longus. The peroneus brevis is absent. O. C. 64 z g.

C. 205. Left hind-foot of Bennett's Wallaby (*Macropus ruficollis*), showing the deep flexor tendons and short flexors of the foot. O. C. 64 z h.

C. 206. Gastrocnemius, soleus, and plantaris from the right hind-limb of a Tree-Kangaroo (*Dendrolagus bennettianus*). The

soleus is attached to the deep surface of the outer half of the gastrocnemius throughout its entire length. The plantaris tendon passes from the inner to the plantar surface of the spirally twisted tendon of the gastrocnemius. O. C. 64 z k. *Presented by F. J. Bennett, Esq.*

- C. 207. The distal portion of the left hind-limb of a Koala (*Phascolarctus cinereus*), showing a powerful pronator muscle of the shank. It arises from the anterior border of the inner side of the head and shaft of the fibula, and passes diagonally downwards to be inserted upon the posterior border of the outer side of the tibia. The head of the fibula articulates with that of the tibia by means of a small facet, allowing of limited motion in an antero-posterior direction. The contraction of the muscle produces a movement of pronation by drawing the fibula obliquely across the tibia. The muscle is usually regarded as a fusion of the popliteus with the pronator tibiæ. Two of the short extensors (*i. e.* iv. & v.) (Peroneus quinti and quarti digiti) rise from the fibula. O. C. 64 z k b.

Presented by Prof. G. B. Howes.

Young, Jour. Anat. & Physiol., vol. xv. 1881, p. 392.

- C. 208. Lower part of the right hind-limb of an Armadillo (*Dasypus sexcinctus*), showing the peronei muscles. The peroneus brevis arises from the femur as well as from the fibula. The p. longus has an additional origin from the patella. The tendon of the peroneus longus before crossing the sole in the usual way, has a strong insertion upon the base of metatarsal v.

Galton, Trans. Linn. Soc., vol. xxvi. 1870, p. 559.

- C. 209. Nerves and superficial muscles of the right hind-limb of an Anteater (*Myrmecophaga jubata*). The muscles of the thigh, more especially those upon the flexor surface, are notable for their strength, as well as for a marked tendency to subdivision; thus, the caudal and ischial heads of the semitendinosus are entirely separate, and the semimembranosus and gracilis are each represented by two distinct

muscles. The biceps has both ischial and femoral heads, of which the latter rises not from the femur but from the deep surface of the femoro-coccygeus. The tensor fasciæ latae, gluteus maximus, and femoro-coccygeus, on the other hand, are fused into a single sheet. The sartorius is weak. The muscles of the shank are in comparison with those of the thigh decidedly feeble. The soleus is quite distinct from the gastrocnemii, and has a separate insertion upon the calcaneum. The accessorius, as in other Anteaters and Sloths, is strongly developed. The short extensors of all the toes but v. rise from the dorsum of the foot. O. C. 64 z k d.

Windle & Parsons, Proc. Zool. Soc. 1899, p. 990.

- C. 210.** Superficial muscles of the right hind-limb of a Three-toed Sloth (*Bradypus tridactylus*). The great strength of flexors and adductors, in comparison with extensors previously mentioned in connection with the fore-limb (C. 146), is equally striking in the hind-limb. This feature is specially marked in the flexors of the knee-joint. Below the knee the muscles on either aspect of the limb are fairly equal in size. The flexors of the knee, apart from their size, owe some of their power to the degree (especially marked in the gracilis and biceps) to which their insertions approximate to the distal ends of tibia and fibula. Mention may be made of the following muscles:—The gracilis, a remarkably strong double muscle, its two parts are inserted about the middle of the tibia and fibula respectively. The biceps cruris is also double, one portion rising from the tuber ischii, the other from the outer side of the femur. This femoral head is again met with in Man and some few Primates. The semitendinosus and semimembranosus form a practically continuous sheet. The two heads of the gastrocnemius are separate to their common insertion on the heel; they cross one another in the lower part of their course. There is no plantaris unless it is represented by the femoral head of the flexor digitorum. The peroneus longus rises partly from the outer condyle of the femur in conjunction with the extensor longus digitorum. The accessorius is very large.

- C. 211. Left hind-limb of Three-toed Sloth (*Bradypus tridactylus*) showing the deeper muscles. The flexor digitorum (flexor fibularis) is very large, it rises from the outer side of the femur above the origin of the gastrocnemius (this part may represent the plantaris), and from a large part of the anterior, inner, and posterior surfaces of tibia and fibula. The tibialis anticus has a double origin, from the upper part of the tibia and from the lower half of the fibula (the second origin may represent the extensor hallucis). Both portions are inserted upon the inner margin of the entocuneiform. This muscle has a powerful supinating action, turning the foot into its usual climbing position with the sole towards the mid-line. (See No. B. 187.)

Humphry, Jour. Anat. & Physiol., vol. iv. 1870, p. 17.

- C. 212. Muscles of the lower part of the left hind-limb of a Two-toed Sloth (*Cholæpus didactylus*). The two heads of the gastrocnemius form distinct muscles with separate insertions on the os calcis; their tendons are longer than in *Bradypus*, and cross one another before reaching the heel. The tendon of the inner head is enveloped by the soleus and soleal origin of the accessorius. The tibialis posticus is double (an Edentate characteristic). A large part of the tendon of the tibialis anticus passes round the inner side of the foot and is attached to the flexor tendons,—by this palmar extension its rotary action must be considerably increased, and at the same time additional power of flexion given to the toes.

Humphry, Jour. Anat. & Physiol., vol. iv. 1870, p. 17.

- C. 213. Right hind-foot of Two-toed Sloth (*Cholæpus didactylus*) showing the muscle insertions. The attachment of the tibialis anticus to the flexor tendons and accessorius is very clearly seen. The flexor tendons show a curious bipenniform striation in their digital part.

- C. 214. Distal part of the right hind-limb of a Guinea-pig (*Cavia porcellus*), showing the double origin of the tibialis

anticus. One head, the largest, rises as usual from the front of the tibia; the other (indicated by black paper) by a long narrow tendon from the external condyle of the femur in close contact with the tendon of origin of the extensor longus digitorum. This femoral origin of the tibialis anticus is frequent among the Caviidæ.

Parsons, Proc. Zool. Soc. 1894, p. 288.

- C. 215. Right hind-limb of a Beaver (*Castor fiber*), showing the superficial muscles of the shank. The flexors of the foot, and particularly the plantaris, are remarkably developed. The soleus joins the outer head of the gastrocnemius in its distal third, but the two gastrocnemial heads are separate throughout their length. The tendons of the gastrocnemius and plantaris are twisted round one another, in such a way that the tendon of the inner gastrocnemial head passes superficial to that of the outer head and of the plantaris to be inserted external to both upon the outer surface of the os calcis. The tendon of the plantaris meanwhile passes in the same direction superficial to that of the outer head of the gastrocnemius. This spiral twisting of the component parts of the tendo Achillis appears to be of very general occurrence among mammals. O. C. 64 z l.

Parsons, Jour. Anat. & Physiol., vol. xxviii. 1894, p. 414.

- C. 216. Nerves and superficial muscles of the left hind-limb of an Elephant (*Elephas africanus*). The ensheathing character of the muscles noticed in the case of the fore-limb, and calculated to give support and rigidity to the joints under the great superincumbent weight, is here even more marked. The external gluteal sheet (tensor fasciæ latæ, gluteus maximus, biceps cruris) in particular is remarkable. It forms a continuous layer coated (especially in its dorsal parts) by yellow elastic tissue. From the knee to the foot the muscle-fibres to a great extent give place to fibrous tissue, which at the back of the leg is confluent with a similar fibrous expansion of the semitendinosus (divided longitudinally in the specimen to show the underlying muscles). The following

features are also of interest:—The sartorius and gracilis, which in the Indian Elephant are poorly developed, seem here to be absent. The semitendinosus and semimembranosus are united along their posterior border. The extensor longus digitorum is fleshy to the level of the metatarsals. O. C. 64 x c.

- C. 217. Distal part of the right hind-limb of an Elephant (*Elephas africanus*), showing the deep muscles. The peroneus longus rises from the outer condyle of the femur. The peroneus brevis is attached to metatarsal iv., and the tibialis anticus to metatarsal ii., an insertion found also in *Hyrae* (*Procavia*). O. C. 64 x d.

Miall & Greenwood, Jour. Anat. & Physiol., vol. xii. 1878, p. 276.

- C. 218. Right hind-foot of a Horse (*Equus caballus*), showing the course of the great tendons and the modified or rudimentary character of the intrinsic muscles. There are two rudimentary interossei rising respectively from the inner surface of each splint bone—their long delicate tendons are lost upon the fetlock. The flexor brevis medii has undergone an important change—similar to that seen in the corresponding muscle of the fore-limb—by the replacement of most of the muscle-fibres by white fibrous tissue. The ligament (suspensory ligament of the fetlock) thus formed forks at its lower end, embraces the first phalanx, and is inserted partly into the plantar sesamoids of phalanx i. and partly into the extensor tendon. It effectually prevents any undue extension of the fetlock (metatarso-phalangeal) joint.

Cunningham, 'Challenger' Reports, vol. v. 1882, p. 94.

- C. 219. Superficial muscles of the right hind-limb of a Calf (*Bos taurus*). The general form of the limb (as already indicated in the case of the fore-limb C. 153) is suggestive of rapidity of movement. The muscles of the thigh—particularly the extensors—are strongly developed, and the flexors of the foot, although not in themselves powerful,

gain a most effective action by their advantageous insertion upon the backwardly prolonged calcaneum. The reduction in the number of the toes and the consequent shifting of the muscle-insertions renders the homology of several of the shank-muscles very uncertain. The following details are noteworthy:—The size of the biceps, and the extension of a slip from its posterior border to the heel. The origin of the sartorius midway between the crest of the ilium and the pectineal process. The large size of the gracilis. The slender and rudimentary character of the soleus. O. C. 64 x g. *Presented by Colonel Burgess.*

- C. 220.** Deep muscles of the left hind-limb of a Calf (*Bos taurus*). A large præ-semimembranosus is present, accompanied by a poorly developed semimembranosus. The several components of the extensor cruris are sharply marked. The tibialis anticus is in two parts—one rising from the front of the tibia, the other in conjunction with part of the extensor longus digitorum from the femur. There are two short extensors rising from the dorsal surface of the tarsus and inserted upon the digits III. & IV.; they are joined in the middle of their course by the tendon of the extensor longus digitorum. The tendons of the flexor fibularis and flexor tibialis unite just distal to the heel, and the common tendon thus formed passes, when on a level with the phalanges, through a loop formed by the plantaris tendon. The tibialis posticus is absent. The short flexors of III. & IV. have been modified as in the Horse to form the suspensory ligament of the fetlock. O. C. 64 x h. *Presented by Colonel Burgess.*

- C. 221.** Superficial muscles of the right hind-limb of a Seal (*Phoca vitulina*). The limb shows great adaptation to a swimming life. As far as the ankle it is closely applied to the body, and is capable mainly of strong rotatory movements. The most important of these (produced by the gracilis, semimembranosus, semitendinosus, and popliteus) takes place inwards and turns the sole of the foot backwards during the stroke. Rotation in the opposite direction is due to the long head of the biceps. The foot is free and

has great powers of flexion and extension. Adduction of the toes, to minimise the resistance of the water during the recovery, is effected by a slight modification of the extensor longus digitorum tendon. The division of the tendon occurs so far down the foot, that the branches are set at a wide angle and upon traction draw the toes together. The tensor fasciæ latae is continuous with the obliquus externus abdominis. The adductors are absent or perhaps fused with the large obturator externus. The biceps is formed of two distinct parts, one of which (short head) rises from the sacral vertebræ, the other (long head) from the tuber ischii. The latter is attached along the whole outer border of the fibula and acts as an outer rotator. The peculiar arrangement of semitendinosus and semimembranosus makes it difficult to decide their homologies with any certainty. The soleus is absent.

- C. 222. A similar specimen of the deep muscles of the left hind-limb. The peroneus longus is attached partly to the external condyle of the femur. The short extensors rise from the dorsum of the foot with the exception of that to v. (peroneus quinti dig.).

Miller, Challenger Reports (Zool.), vol. xxvi. 1888, p. 176; Lucæ, Abhandl. Seckenberg. Natur. Gesellsch., Bd. ix. 1873-75, p. 448.

- C. 223. Distal portion of the right hind-limb of a Dog (*Canis familiaris*), showing the muscles of the shank and foot. The plantaris is of great size and is fused at its origin with the outer head of the gastrocnemius. The main tendons of the flexor tibialis and flexor fibularis are united in the sole of the foot. An extensor brevis digitorum v. (peroneus quinti) is present, rising as usual from the proximal part of the fibula. The short extensors II., III., IV. are well-developed and rise from the dorsum of the foot. The tibialis posticus, extensor hallucis, and flexor tibialis, owing apparently to the absence of the hallux, are all more or less rudimentary. The soleus is absent. O. C. 64 z q b.

Presented by Prof. McFadyean.

- C. 224. Part of the left hind-limb of a Dog (*Canis familiaris*). The tendon of the plantaris passes in a semispiral round the inner side of that of the gastrocnemius; it is not wholly attached to the calcaneum but passes over its surface and is continued into the flexor brevis digitorum. A small pronator tibiæ is present. O. C. 64 z q c.

Presented by Prof. McFadyean.

Gruber, Arch. f. Anat. und Physiol., 1878, p. 438.

- C. 225. The superficial muscles of the right hind-limb of a Lemur (*Lemur mongoz*). In this arboreal animal the extensor muscles are decidedly feeble; the flexors of the knee, on the other hand, have considerable power, mainly owing to their insertion at some distance below that joint. The sartorius, gracilis, and semitendinosus unite near their distal extremities and are inserted by a common tendon. The biceps rises from the proximal part of the anterior border of the semitendinosus. The præ-semimembranosus, as in other Lemurs, is absent. The tibialis anticus is inserted by two tendons. The flexor brevis digitorum rises by two separate heads: 1, from the plantar fascia; 2, from the deep flexor tendons, this latter part may include the accessorius. O. C. 64 m b h.

Presented by Prof. F. G. Parsons.

Parsons, Jour. Anat. & Physiol., vol. xxxii. 1898, p. 741.

- C. 226. Distal portion of the left hind-limb of a Lemur (*Lemur mongoz*), showing several of the deep muscles. A pronator tibiæ is present between the heads of the tibia and fibula. Its fibres pass slightly downwards from the fibula. A corresponding muscle is situated between the distal ends of the same bones. The two outermost short extensors (peroneus quarti dig. et quinti dig.) rise from the fibula, those belonging to the inner three toes from the dorsum of the foot as usual. A blue rod has been placed beneath the second part of the flexor brevis (see preceding specimen), and a green rod under the lumbricals. O. C. 64 m b g.

Presented by Prof. F. G. Parsons.

Murie & Mivart, Trans. Zool. Soc., vol. vii. 1872, p. 74.

- C. 227. Right hind-limb of *Macacus maurus*, showing the superficial muscles. The climbing habits of the monkey are indicated by the comparative weakness of the extensor cruris, the insertion of the flexors of the knee, especially the gracilis and semitendinosus, far down the shank, and the considerable development of the posterior (femoro-coccygeal) part of the ectogluteal sheet. The following details are of interest in comparison with other Primates:—The gluteus maximus is continuous anteriorly with the tensor fasciæ latae, but is separated posteriorly by a gap from a large muscle that rises from the tuber ischii and is inserted partly into the fascia covering the lower part of the thigh and partly into the fibula. The anterior portion of this muscle apparently represents the femoro-coccygeus; the posterior portion, the ischial head of the biceps. There is no femoral head to the biceps. The insertion of the gracilis is continued by a fibrous expansion to the heel. There is a well-marked præ-semimembranosus. The tibialis anticus divides distally into two separate parts inserted respectively by tendon into the internal cuneiform and metatarsal 1. The calf muscles are weak. The soleus is fleshy to the heel. O. C. 64 m b.

Presented by J. Abrahams, Esq.

Haughton, Proc. Roy. Irish Acad., vol. ix. 1867, p. 278.

- C. 228. Superficial muscles of the left thigh of a Baboon (*Papio* [*Cynocephalus*] *babuin*). The muscles show in general a high degree of development. Those that form the ectogluteal layer are stronger and far more separate than in *Macacus*. A præ-semimembranosus is present. The components of the extensor cruris are strong and very definite. The ischial head of the biceps is fused, as in *Macacus*, with the femoro-coccygeus; there is no femoral head. O. C. 64 κ.

- C. 229. Superficial muscles of the right shank and foot of a Baboon (*Papio* [*Cynocephalus*] *babuin*). The calf muscles are more powerful than in *Macacus*. The plantaris is of considerable size, and the soleus independent and fleshy to the heel. The tibialis anticus resembles that of *Macacus*. O. C. 64 l.

C. 230. Muscles of the left foot of a Baboon (*Papio* [*Cynocephalus*] *babuin*). The accessorius is well marked. The flexor brevis digitorum has two separate points of origin: 1, from the calcaneum with insertion upon II.; 2, by several fasciculi from the conjoined deep flexor tendons, this part sends tendons to digits III., IV., V. There is an independent muscle-slip situated upon the plantar surface of the abductor V. The tendons of the extensor brevis to I. and II. rise from a single belly. O. C. 64 M.

C. 231. The right hind-limb of a Crested Baboon (*Cynopithecus niger*), showing the semimembranosus and præ-semimembranosus, the duplicity of the tibialis anticus for the distal half of its course, and the independent insertion of the soleus. O. C. 64 M b e.

C. 232. Nerves and superficial muscles of the right hind-limb of a Gibbon (*Hylobates leuciscus*). The muscles are of slender build, with no great intrinsic strength, but, as in so many other arboreal creatures, the power of the flexors of the knee is largely increased by their insertion at a considerable distance below the joint. The muscles of the ectogluteal layer form a continuous sheet, with the exception of a certain degree of individuality in the tensor fasciæ latæ towards its insertion. The biceps has both ischial and femoral heads which unite as in Man to form a single tendon inserted on the fibula. The sartorius, gracilis, and semitendinosus form (as in the Lemur C. 225) a common tendon inserted partly on the tibia, partly continued downwards into the superficial fascia of the leg. The sartorius in this and the other anthropomorphous apes rises from the ilium considerably farther back than in Man. The flexor brevis digitorum rises, as in the lower Primates and Lemurs, partly from the deep flexor tendons, its calcaneal head supplies II., that from the flexor tendons III., IV., and V. O. C. 64 M l.

C. 233. Nerves and deeper muscles of the left hind-limb of a Gibbon (*Hylobates leuciscus*). The præ-semimembranosus

is not separate from the adductor magnus, although it may possibly be represented by the slender round tendon that continues from the distal limit of the insertion of the adductor magnus to the supracondyloid ridge. The soleus rises by a round tendon from a very small area of the fibula (the origin is far more extensive in other Anthropoids) and is fleshy to the heel. Plantaris and accessorius are absent. O. C. 64 M k.

- C. 234. Superficial muscles of the right hind-limb of an Orang-Outang (*Simia satyrus*). This Anthropoid exhibits but little agility while in captivity, and is seldom observed to go on all fours after the manner of quadrupeds, or the inferior Apes, but in using its long arms in progressive motion on the ground, it supports itself on the bent fingers as on a pair of crutches and swings the body forward between them. The diminutive hind limbs, with their long hook-like digits and greatly reduced halluces, appear to be especially destined for the actions of grasping and climbing, and are by no means calculated to support the body erect, although capable of doing so for a short time. There is no tensor fasciæ latae. The femoro-coccygeus is separate from the gluteus maximus; it rises in common with the ischial head of the biceps, and is inserted as usual upon the femur superficial to the origin of the femoral head of the biceps. This partial fusion of the femoro-coccygeus with the biceps is interesting, in comparison on the one hand with the Baboon and Macaque (C. 227 & 228) in which the two are entirely confluent, and on the other hand with the rest of the Anthropoids in which the femoro-coccygeus is united to the gluteus maximus. The two heads of the biceps have a slight muscular connection close to their insertion. The pectineus is in part continuous with the adductor longus. O. C. 64 M e.

Presented by C. Dent, Esq.

- C. 235. Left hind-limb of an Orang-Outang (*Simia satyrus*) showing the deeper muscles. The præ-semimembranosus is not separate. The flexor fibularis (flex. long. hallucis) has a strong condylar origin. A larger part of the flexor

brevis is calcaneal than in the Gibbon—this part supplies II. & III.; that rising from the deep flexor tendons, IV. only. The plantaris is absent. O. C. 64 Mf.

Presented by C. Dent, Esq.

- C. 236. Right hind-limb of an Orang-Outang (*Simia satyrus*), showing more particularly certain of the deeper muscles surrounding the hip-joint and those upon the plantar surface of the foot. The scansorius is well marked. In the foot there is a small flexor accessorius. The flexor fibularis (flex. long. hallucis) supplies III. & IV. The flexor tibialis (flex. longus digitorum) II. & V. There is no deep tendon to the hallux. O. C. 64 Mg.

Presented by Victor Horsley, Esq.

- C. 237. Left knee of an Orang-Outang (*Simia satyrus*), showing the origin of the popliteus from the joint-capsule and fibula-head as well as from the more ordinary position on the external femoral condyle. O. C. 64 Mh.

Presented by Victor Horsley, Esq.

- C. 238. Right hind-limb of a Gorilla (*Anthropopithecus gorilla*), showing the superficial muscles. The ectogluteal sheet is continuous. The two heads of the biceps are entirely separate at their insertion. The muscle-fibres both in the gastrocnemius and soleus extend to the heel. There is no plantaris. O. C. 64 Nc.

- C. 239. Deep muscles of the left hind-limb of a Gorilla (*Anthropopithecus gorilla*) with arteries. There is a well-marked præ-semimembranosus. O. C. 64 Nd.

- C. 240. The deep plantar tendons from the left foot of a Gorilla (*Anthropopithecus gorilla*), with the flexor brevis digitorum, accessorius and lumbrical muscles. The flexor fibularis (flex. long. hallucis) sends tendons to I., III., IV., and a strengthening slip to the tendon of II. The flexor tibialis (flex. long. digitorum) supplies II. & V. The calcaneal

portion of the flexor brevis provides tendons for II. & III., while IV. & V. are supplied by the portion that rises from the plantar tendons. The accessorius though present is weak. Only two lumbricals are shown. O. C. 64 N.

- C. 241. Superficial muscles of the right hind-limb of a Chimpanzee (*Anthropopithecus troglodytes*). There is a distinct though small tensor fasciæ latae. The gluteus maximus and femoro-coccygeus are closely united. The ischial and femoral heads of the biceps cruris do not unite before their insertion. The semitendinosus shows a delicate tendinous intersection in the middle of its length. A separate præ-semimembranosus is present. The tibialis anticus is double for some distance above the annular ligament. A fine tendon, probably representing the extensor brevis V., separates off from the peroneus brevis and runs along the dorsum of V. to the phalanges.

Presented by John Marshall, Esq.

- C. 242. Nerves and deep muscles of the left hind-limb of a Chimpanzee (*Anthropopithecus troglodytes*). A plantaris is present.

Presented by John Marshall, Esq.

- C. 243. The left deep flexor tendons with the flexor brevis digitorum and lumbrical muscles of a Chimpanzee (*Anthropopithecus troglodytes*). The flexor tibialis (flex. long. digitorum) supplies a tendon to V. and the greater part of that to II. The flexor fibularis (flex. long. hallucis) sends tendons to I., III., IV., and strengthens that to II. The flexor brevis has origins from both calcaneum and the tendons of flex. tibialis, the former supplies II. & III., the latter IV. & V. The tendon to II. is also enforced by a large muscular slip from the flexor tibialis tendon.

- C. 244. A vertical section of the Human tibia and patella, and of the tendon of the extensors of the leg, showing the distance to which the tendon is removed from the centre of motion by the interposition of the latter bone. O. C. 277.

Hunterian.

- C. 245. Right deep plantar tendons of a Bushwoman, with the flexor brevis digitorum, accessorius, and lumbrical muscles. The flexor fibularis (flex. long. hallucis) sends a large tendon to I., and strengthening slips to the three inner tendons of the flexor tibialis (fl. longus digitorum). The accessorius is inserted into both flexor fibularis and tibialis. The flexor brevis digitorum of II., III., IV. rises from the calcaneum; that to V. forms a separate muscle and, as in most lower Primates, takes origin from the tendon of the flexor tibialis. O. C. 64 x.

Flower & Murie, Jour. Anat. & Physiol., vol. i. 1867, p. 203.

- C. 246. Right deep plantar tendons of Man. The flexor fibularis (fl. longus hallucis) goes mainly to I., but also sends strengthening slips to the two inner tendons of the flexor tibialis (flex. longus digitorum).



